E. R. Garrison

# JOURNAL OF DAIRY SCIENCE

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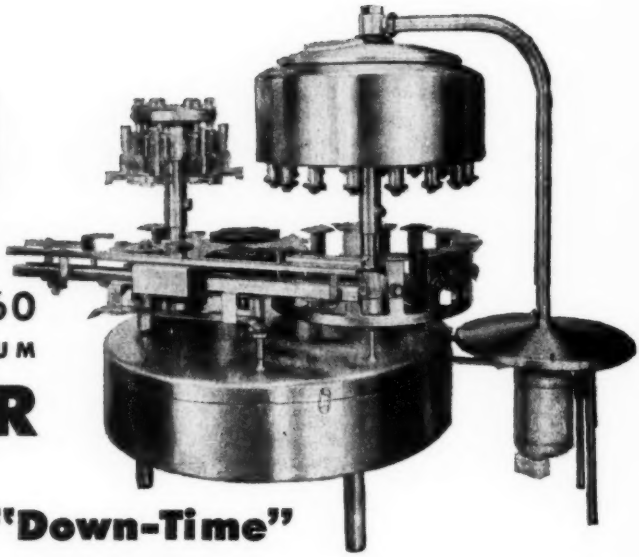

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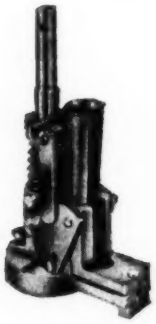

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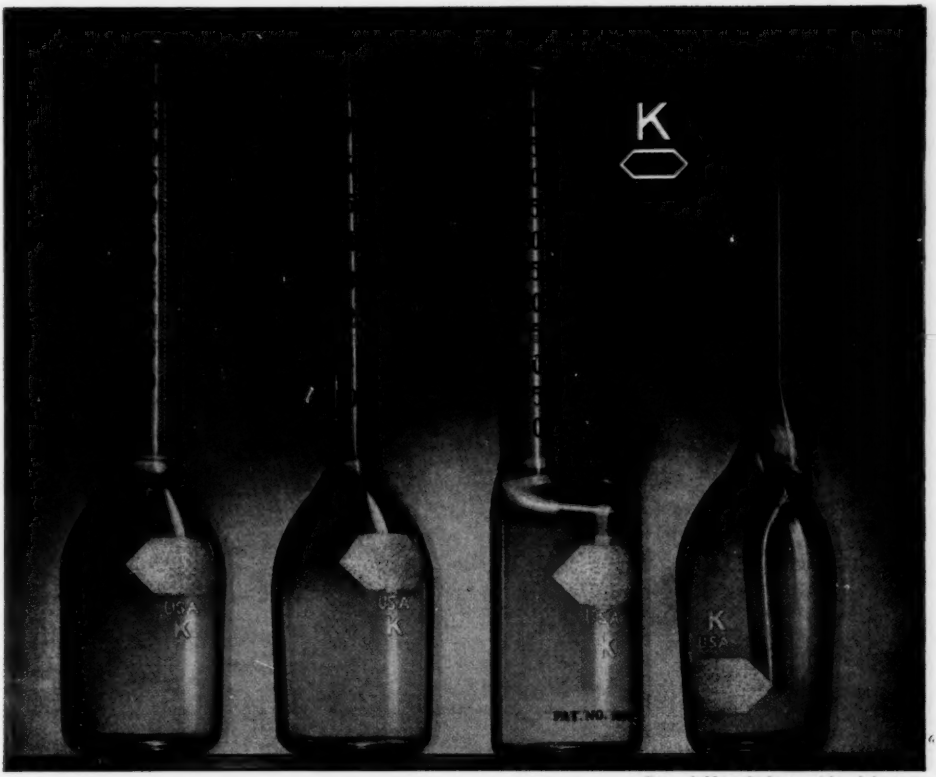


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VOLUME XXXVII March, 1954 NUMBER 3

# THE EFFECT ON MILK PRODUCTION OF LEGUME SILAGE HARVESTED IN THE BUD STAGE VS. FULL BLOOM STAGE OF MATURITY OF ALFALFA

V. S. LOGAN

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*Central Experimental Farm, Ottawa, Canada*

Legume and grass silages are receiving increased attention in Canada as a feed for dairy cattle. Interest in this type of roughage has been stimulated by a better knowledge of methods of harvesting and storing the hay crop as silage. Also, storing the hay as silage is a means of preserving the nutritive value of the roughage when weather conditions are adverse for haymaking. If established procedures are followed, grass and legume crops can be ensiled successfully at any stage of growth at which they are suitable for good hay production.

It is considered generally that the early cut hay crop when ensiled is of higher nutritive value than the more mature material, but data on the effect of stage of cutting on milk production are limited.

Comparing alfalfa hays cut at three stages of maturity, Dawson *et al. (2)* showed that hay cut in the initial and half bloom stage of maturity gave higher milk yields than that cut in full bloom. The nutrients furnished by the earlier cut material appeared to be more efficient as a feed than those from hay cut at the later stages. Feeding trials at the Arizona Agricultural Experiment Station *(6)* showed little difference in milk production between cows fed alfalfa (Hairy Peruvian) cut in the bud stage as compared to the same crop cut at one-third bloom stage of maturity. Dodsworth and Campbell *(3)* fed steers grass silage cut at three stages of growth. That cut in the "grazing stage," and a later cutting, made before "shooting stage," were superior to similar roughage cut after "shooting," from the standpoint of rate of fattening.

The experiment reported here was conducted at Ottawa to determine the effect on milk production of alfalfa silage cut at two stages of maturity. Two levels of protein supplement were fed with each type of silage to determine if any differences that might be demonstrated in the feeding value of the silages were due to their protein content.

Received for publication July 13, 1953.

## EXPERIMENTAL

The crop from one field consisting of approximately 90% legume and 10% timothy grass was harvested for silage at two stages of cutting. The first cutting was made when the alfalfa was in the bud stage of maturity. The later cutting was harvested when the alfalfa had reached full bloom. The cuttings were stored in separate tower silos of similar construction.

Twelve cows in early stages of lactation were used for the feeding trial. These were divided into three groups according to the design outlined by Cochran *et al. (1)*. The four cows in each group were matched as closely as possible relative to age, body weight, stage of lactation, and milk production. The design of the feeding experiment permitted comparison of four types of rations.

In order to determine if any differences expected in the two cuttings of silage might be due to crude protein content, two levels of protein were used in the meal rations fed with each of the two types of silage.

The rations were constituted as follows:

| *Ration* | *Meal* | *Silage* | *Hay* |
|---|---|---|---|
| A | 11.5% dig. protein | full bloom cut | legume |
| B | 8.5% dig. protein | full bloom cut | legume |
| C | 11.5% dig. protein | bud stage cut | legume |
| D | 8.5% dig. protein | bud stage cut | legume |

Silage was fed at the rate of 5 lb., and hay at ½ lb. per 100 lb. live weight daily. The hay was of fair quality similar to the silage in botanical composition. A mixture of oats and barley was used for the low protein meal supplement. Linseed oil meal was added to the oat and barley mixture to make up the higher protein supplement. The meal allowance was based on Morrison's *(5)* feeding standard for "usual feeding with good hay," adjusted each week in accordance with the daily production of the previous week. The trial was conducted over a period of 20 weeks. It consisted of a preliminary period of 1 week and four experimental periods of 4 weeks each, interspaced by change-over periods of 1 week.

Digestibility determinations on the two silages were made with steers at the same time the feeding experiment was being conducted. Samples of each of the feed ingredients were collected during each experimental period for chemical analyses. The digestible crude protein (DCP) and the total digestible nutrients (TDN) consumption were estimated from the analyses of the feeds and the digestibility determinations carried out by the Division of Chemistry, Science Service.

The chemical analyses and the TDN content of the two silage cuttings are shown in Table 1.

## RESULTS AND DISCUSSION

The results of this trial are summarized in Table 2. Since changes in body weight were not found to be significant, the yield of fat-corrected milk

TABLE 1

*Chemical composition of silage and calculated total digestible nutrients at time of feeding*

| Silage cutting | Dry matter | Protein [a] | Crude fiber | Ether extract | N. free extract | Ash | TDN |
|---|---|---|---|---|---|---|---|
| | *(%)* | | *(as per cent of dry matter)* | | | | *(%)* |
| Bud stage | 21.8 | 14.7 | 36.8 | 2.6 | 36.8 | 9.1 | 55.6 |
| Full bloom stage | 21.6 | 14.4 | 38.1 | 2.4 | 36.7 | 8.4 | 53.7 |

[a] Nitrogen × 6.25.

TABLE 2

*The effect of feeding legume silage, cut at two stages of maturity, fed with two levels of meal protein, on production and nutrient consumption of dairy cows (mean values for 4-week period)*

| Rations | A | B | C | D |
|---|---|---|---|---|
| Silage cuttings | Full bloom | Full bloom | Bud stage | Bud stage |
| Meal supplement | 11.5% dig. protein | 8.5% dig. protein | 11.5% dig. protein | 8.5% dig. protein |
| | *(lb.)* | *(lb.)* | *(lb.)* | *(lb.)* |
| FCM | 802.7 | 828.5 | 854.5 [a] | 869.4 [a] |
| Change in body wt. | −2.6 | −0.6 | 1.0 | −3.2 |
| TDN consumed | 465.7 | 471.0 | 479.6 [b] | 480.4 [b] |
| DCP consumed | 77.6 [c] | 70.2 | 82.0 [c] | 72.5 |
| TDN required per 100 lb. FCM | 58.0 | 56.8 | 56.1 | 55.3 |

DCP—Digestible crude protein.

[a] $P < 0.05$—Significant over A and B.

[b] $P < 0.01$—Significant over A and B.

[c] $P < 0.01$—Significant over B and D.

(FCM) *(4)* was considered to be a fairly direct measure of the effects of the rations fed. The milk yield was significantly higher ($P < 0.05$) during the periods the cows were fed silage cut in the bud stage (Rations C and D) than when fed silage cut in the full bloom stage of maturity (Rations A and B). It will be noted further in Table 2 that the higher milk yield was directly associated with a significantly higher intake of TDN ($P < 0.01$). The trend in production actually appears to favor the lower protein intake under the conditions of this experiment, although these differences were not significant. There was no significant difference in the efficiency of the rations as measured by the TDN required to produce 100 lb. of milk.

The amounts of the feed ingredients consumed while on the respective rations, together with a breakdown of the digestible crude protein and the total digestible nutrients supplied by the respective feed ingredients, are shown in Table 3. It is evident from these data that the greater amount of TDN consumed while on rations C and D as compared to rations A and B was supplied by the meal or concentrate portion of the ration. Based on the feeding standard allowance of TDN for milk production, this higher intake of TDN would account for a large portion of the increased milk yield shown. Since the rate of concentrate feeding was governed during each weekly interval by the milk production

TABLE 3

*Amount of feed consumed by cows while on the respective rations and nutrients supplied by feed ingredients (mean values for 4-week period)*

| Rations | A | | | B | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feed ingredients | Grain 11.5% protein | Hay | Full bloom silage | Grain 8.5% protein | Hay | Full bloom silage | Grain 11.5% protein | Hay | Bud stage silage | Grain 8.5% protein | Hay | Bud stage silage |
| Feed consumed *(lb.)* | 271.3 | 189.9 | 1820.5 | 275.6 | 182.5 | 1820.3 | 286.4 | 180.5 | 1829.8 | 286.2 | 184.1 | 1834.1 |
| Digestible protein intake *(lb.)* | 31.1 | 10.0 | 36.5 | 23.3 | 10.2 | 36.6 | 33.3 | 10.7 | 38.1 | 24.3 | 10.2 | 38.0 |
| TDN intake *(lb.)* | 184.9 | 81.9 | 199.0 | 191.0 | 82.6 | 197.3 | 199.5 | 81.7 | 198.5 | 199.1 | 83.3 | 197.9 |

rate of the previous week, there is a suggestion that the early cut silage may have a slight advantage in maintaining the level of production.

Analyses of samples of the silages taken during the experimental periods (Table 1) showed very little difference in the chemical constituents when the silage was cut in the bud stage as compared to similar material cut in the full bloom stage of maturity. The chief difference was that the early cut material showed a slightly lower crude fiber content and was slightly higher in total digestible nutrients.

## SUMMARY

Rations containing legume silage harvested in the bud stage of alfalfa gave significantly greater milk yields than when the alfalfa was ensiled at full bloom. This difference was not appreciably influenced by varying the supplemental meal allowance from 8.5 to 11.5% digestible crude protein.

Since little difference was found in the chemical analyses and digestibilities of the two silage cuttings, it was concluded that the higher yield obtained from the early cut material was due to the higher TDN content of the rations containing these silages.

## ACKNOWLEDGMENT

The author acknowledges the helpful direction of K. Rasmussen, Chief, Animal Husbandry Division, Experimental Farms Service, and the assistance of J. Batty, herdsman, in carrying out the feeding details of the experiment. A. R. G. Emslie and G. Brisson, Animal Chemistry, Science Service, carried out the digestion trials and offered suggestions for the preparation of this paper.

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# SOME FACTORS AFFECTING AGE AT PUBERTY IN HOLSTEIN-FRIESIAN HEIFERS[1]

H. W. HAWK, W. J. TYLER,[2] AND L. E. CASIDA
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*Madison, Wisconsin*

Age at puberty in the heifer is a reproductive phenomenon of importance in dairy production. Breeding efficiency may be lowered by extreme delays in occurrence of estrus; possible interrelations with growth rate, mammary development, and fertility also may exist.

That age at puberty is influenced by both genetic and environmental factors has been shown by many investigators. Mirskaia and Crew *(10)* concluded that relatively early and relatively late ages at puberty in mice were hereditary. Blunn *(2)* found hereditary differences in age at vaginal opening in different strains of rats and also noted that faster growing rats tended to reach puberty at an earlier age than slower growing ones. Engle, Crafts, and Zeithaml *(5)* determined that female rats from small litters reached puberty at an earlier age than females from large litters, mainly as the result of differences in growth rate. Asdell and Crowell *(1)* observed that age of vaginal opening in rats could be delayed by limiting the calorie intake and thus retarding growth.

According to Upp and Thompson *(18)*, pullets hatched during the normal hatching season were slower to reach sexual maturity than those hatched during other seasons of the year. Riddle *(14)* reported a similar seasonal effect in doves and pigeons. Hammond *(6)* found rabbits born during the spring months to be older at the first fertile mating than those born during other months of the year.

McKenzie *(9)* concluded that a low plane of nutrition retarded body growth and development of the reproductive organs in gilts. Phillips and Zeller *(11)* noted that large and small type Poland China gilts differed in age at puberty, averaging 199 and 208 days, respectively. Warnick *et al. (19)* showed a significant negative correlation between weights at 56 and 154 days and age at puberty in inbred gilts. Robertson *et al. (15)* observed a similar negative correlation in outbred gilts. Squiers *et al. (17)* obtained evidence that crossbred

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[2] Agent of the Bureau of Dairy Industry.

gilts reached sexual maturity at an earlier age than inbred gilts, which was attributed to the more rapid growth of the crossbreds. The work of Wiggins *et al. (20)* indicated that gilts born during the spring season were slower to reach puberty than those born during other seasons of the year. Reid *et al. (12)* reported that puberty in Holstein heifers was delayed by a subnormal level of nutrition and hastened by a supernormal level.

The study reported here was an analysis of some of the sources of variation in age at puberty in Holstein-Friesian heifers and of the possible relation of this variability to breeding efficiency. Differences between sire-groups, the effects of inbreeding, calfhood scours, growth rate, season of birth, and certain interactions among these factors have been examined.

## MATERIALS AND METHODS

Data for this report were collected from the Holstein-Friesian herd at the Emmons Blaine, Jr., Experimental Farm, Lake Mills, Wisconsin. The heifers used were from six sire-groups, a sire-group being defined as both the inbred and outbred daughters of a particular sire. Data were analyzed from 40 outbred and 27 inbred heifers, which included all the females born in the experimental herd between October 25, 1948, and January 1, 1951, and raised to breeding age. Coefficients of inbreeding for the inbred animals ranged from 0.16 to 0.29, the average being 0.24.

Heat checks (observations of the behavior of females running together in the exercise yard) were made twice daily on all heifers over 6 months of age. Puberty was considered as occurring at the time of the first observed heat. The reproductive organs of each heifer were examined by rectal palpation during the last 7 days before 455 days of age; if approved for breeding, each heifer was artificially inseminated at the first estrus after 454 days of age.

## RESULTS AND DISCUSSION

Average puberal age for the 67 heifers was 397 days; the standard deviation was 54 days and the coefficient of variation, 13.7. This group of heifers reached puberty at a considerably later average age than the 9 months reported by Hammond *(7)* or the 4-8 months listed by Rice and Andrews *(13)*.

TABLE 1

*Effect of sire-group and system of mating on age at puberty*

| System of mating | Sire-group | | | | | | Unweighted mean for system of mating |
|---|---|---|---|---|---|---|---|
| | *O* | *L* | *H* | *B* | *M* | *N* | |
| | *(Age in days)* | | | | | | |
| Inbred | 434 (7) [a] | 416 (4) | 399 (4) | 384 (4) | 429 (3) | 409 (5) | 412 |
| Outbred | 375 (3) | 388 (5) | 366 (6) | 375 (7) | 393 (8) | 400 (11) | 383 |
| Unweighted mean of sire-group | 404 | 402 | 382 | 380 | 411 | 404 | |

[a] Denotes number of heifers in the group.

The method of unweighted means *(16)* was used to analyze the variance of the age at first heat when classification of the heifers was made by sire-groups and system of mating (Table 1). The differences among sires were not significant. The over-all difference in age between inbreds (412 days) and outbreds (383 days) approached significance ($P \cong 0.08$).

Seventeen of the 27 inbred heifers (63%) and 24 of the 40 outbreds (60%) contracted calfhood scours. The majority of cases occurred by 2 weeks of age and lasted from 1 to 5 days; eight cases persisted for 5 to 10 days. Most calves afflicted were born in 1950.

When the heifers were classified by occurrence of calfhood scours and by system of mating, the following mean ages at puberty were found (Table 2): 364 days for the nonscouring outbred group, 400 days for outbreds that scoured, 418 days for nonscouring inbreds, and 411 days for the inbreds that scoured.

TABLE 2

*Effect of system of mating and occurrence of calfhood scours on weight at 3 months and age at puberty*

| Occurrence | Inbreds | | Outbreds | |
|---|---|---|---|---|
| | Wt. | Age | Wt. | Age |
| | *(lb.)* | *(days)* | *(lb.)* | *(days)* |
| Scours | 172 (17) [a] | 411 | 189 (24) | 400 |
| No scours | 185 (10) | 418 | 209 (16) | 364 |

[a] Denotes number of heifers in the group.

Analysis of variance by the method of unweighted means showed a significant difference ($P < 0.05$) among the four groups: nonscouring outbreds were found to differ significantly ($P < 0.05$) from each of the three other groups *(4)*. No significant differences were found between any two of the three groups that averaged 400 days or more in age at first heat. It thus appears that inbreeding or calfhood scours, or both, cause a substantial delay in age at puberty in dairy heifers.

If the age at puberty of the nonscouring outbred heifers, 364 days, is regarded as an average age under normal conditions, this group of heifers did not differ greatly from the 11.3 months observed by Reid *et al. (12)* for heifers on a normal level of nutrition.

Inbreeding or scouring, or both, may possibly delay puberty by retarding calfhood growth, which in turn inhibits sexual development. Highly significant positive correlations between body weight and ovarian, follicular, and uterine development were found by Casida *et al. (3)* in Holstein calves aged from a "few" days to approximately 14 weeks. Although much of the variation in calf weight was undoubtedly caused by variation in age, the relationship between weight and sexual development may well have reflected the action of factors additional to age.

At 3 months of age the average weight of nonscouring outbred heifers was significantly greater than the average weight of the three other groups ($P < 0.01$ to $< 0.02$) when the heifers were classified by system of mating and

occurrence of calfhood scours (Table 2). The two groups influenced by only one inhibitory factor, such as inbreeding or scouring, averaged approximately the same in weight, whereas the group affected by both factors was further retarded in rate of growth (probabilities of 0.05 and 0.12). Similar differences were found also from an analysis of the weights at 6 months of age.

A highly significant association was found between age at puberty and weight at both 3 and 6 months ($r = -0.42$ at each age over all heifers studied; $b = -0.93$ days and $-0.54$ days at 3 and 6 months, respectively). No significant differences were found at either age among the correlations or regressions within

TABLE 3

*Effect of scouring and system of mating on the association between age at puberty and weight at 3 and 6 months of age*

| System of mating and occurrence of scouring | d.f. | 3 months of age | | 6 months of age | |
|---|---|---|---|---|---|
| | | r | b | r | b |
| | | | *(days)* | | *(days)* |
| Scouring inbreds | 15 | −0.40 | −0.84 | −0.54 [a] | −0.76 [a] |
| Nonscouring inbreds | 8 | 0.01 | 0.02 | −0.10 | −0.15 |
| Scouring outbreds | 22 | −0.31 | −0.62 | −0.21 | −0.27 |
| Nonscouring outbreds | 14 | −0.54 [a] | −1.96 [a] | −0.46 | −0.86 |

[a] $P < 0.05$.

each of the four different groups resulting from classification of the heifers by system of mating and occurrence of scouring (Table 3). Nonscouring outbreds by themselves showed a significant correlation at 3 months ($r = -0.54$) and one which approached significance at 6 months ($r = -0.46$). A significant association existed in the scouring-inbred group at 6 months ($r = -0.54$) and approached significance at 3 months ($r = -0.40$).

The finding of an association between age at puberty and rate of growth suggested the possibility that scouring and inbreeding delayed puberal age in these heifers by retarding their growth rate. A test of this possibility was made by adjusting the puberal ages for differences in weight at 3 or 6 months. No significant differences in age at puberty were then found among the four groups ($P \cong 0.50$), which suggests that the action of scouring and inbreeding on age at puberty is due largely to their action on the rate of growth.

When heifers were classified by sire and system of mating, highly significant negative correlations were found between age at puberty and weight at 3 or 6 months within the resulting groups ($r = -0.39$ and $-0.42$; $b = -0.99$ days and $-0.65$ days at 3 and 6 months, respectively). The within-sire correlations for the inbred heifers at either age (Table 4) did not differ significantly from the within-sire correlations for the outbred heifers at the same ages. The between-sire correlations were not significant for either inbreds or outbreds, and the between-sire and within-sire correlations did not differ significantly for either system of mating.

Classification of the heifers by occurrence of scouring, system of mating, and season of birth resulted in subclasses which were too small for critical

TABLE 4

*Effect of sire and system of mating on within-sire and between-sire correlation of age at puberty and weight at 3 or 6 months of age*

| System of mating | Association | d.f. | 3 months of age | | 6 months of age | |
|---|---|---|---|---|---|---|
| | | | r | b | r | b |
| | | | | *(days)* | | *(days)* |
| Inbred | Within-sire | 20 | −0.13 | −0.31 | −0.26 | −0.41 |
| | Between-sires | 4 | −0.27 | −0.40 | −0.26 | −0.21 |
| Outbred | Within-sire | 33 | −0.50 [a] | −1.32 [a] | −0.48 [a] | −0.73 [a] |
| | Between-sires | 4 | −0.25 | −0.29 | 0.14 | 0.10 |

[a] $P < 0.01$.

analysis. Since no evidence was found that scouring or inbreeding affected puberal age other than through their effect on the rate of growth, an analysis to detect possible effects of season of birth on the age at puberty was made by using puberal ages adjusted for differences in weight of the individual heifers at 3 months of age. The following averages were then found for heifers born during the different calendar seasons: winter, 404 days (19 heifers); spring, 367 days (22 heifers); summer, 400 days (8 heifers) and fall, 425 days (18 heifers). Heifers born in the spring reached puberty at a significantly earlier age than those born during each of the other seasons ($P < 0.01$ to $P < 0.02$). The mean puberal ages for heifers born during the summer, fall, and winter did not differ significantly from each other.

These heifers behaved contrary to birds, rabbits, and swine in that the animals born during the spring, the presumed natural season of birth, reached puberty at the earliest age rather than being the slowest to mature, as noted in the other species. Perhaps this suggests that it is not the season at which puberty is actually attained which is important, but rather the season at some critical stage antecedent to puberty. That changes in amount of light is the factor which causes the seasonal variation in age at first estrus seems to be a pertinent hypothesis. A study of the effects of experimental light-modification on animals born at different seasons appears necessary, however, to identify the necessary change in light and the latent period for it to be effective.

After finding that puberal ages were affected by season of birth and by growth rate (which appeared to account for the effects of inbreeding and calfhood scouring), the ages were adjusted for differences in growth rate and season of birth and re-analyzed for differences between sire-groups. Again, however, the differences between these six sire-groups were found to be non-significant.

Heifers in breeding condition were bred at the first and any succeeding heat periods after 454 days of age and were allowed 233 days to conceive before removal from the herd as infertile. An index of breeding efficiency was calculated for each heifer as 100% minus the percentage of the 233 days that she lost before conception, an adjustment being made for any detected pregnancy that was lost.

A highly significant negative correlation ($r = -0.33$) was found between

age at puberty and breeding efficiency. Nine of the 67 heifers (13%) failed to reach puberty until after the breeding age of 455 days was attained. Such a loss of time due to delay of first estrus could be of considerable importance in decreasing the over-all breeding efficiency of a heifer herd.

Since age at puberty and breeding efficiency were automatically correlated in the heifers reaching puberty after 455 days, their breeding efficiencies were recalculated excluding the time lost before age at first heat. The relationship between the two factors was then no longer significant ($r = -0.15$). Thus, no indication was found that the length of time a heifer had been sexually mature before she was first bred had an effect on her fertility. A further test of this was made by evenly dividing the heifers into an early and a late group to reach puberty and comparing the number of services per conception. The earlier group to reach puberty required 2.00 services; the later group required 2.26. The averages did not differ significantly.

## SUMMARY

The effects of inbreeding, calfhood scouring, and season of birth on age at first heat were studied in six sire-groups of Holstein-Friesian heifers, totaling 67 animals. No statistically significant differences were found in puberal age among the sire-groups. Inbreeding and calfhood scouring were found to delay age at puberty and also to retard calfhood growth significantly. A highly significant negative correlation was found between age at puberty and weight at 3 or 6 months of age. Adjustment of puberal ages for differences in weight at 3 or 6 months yielded evidence suggesting that inbreeding and/or calfhood scouring increased age at puberty by retarding growth. Heifers born during the spring were found to reach puberty at a significantly earlier age than those born during other seasons of the year. No evidence was found that age at puberty is associated with the readiness with which heifers conceived.

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# ANTIBIOTICS IN DAIRY CATTLE NUTRITION. III. EFFECTS OF DIFFERENT LEVELS OF AUREOMYCIN INTAKE UPON THE GROWTH AND WELL-BEING OF DAIRY CALVES, AND THE ASSOCIATION OF DIFFERENCES WITH CHANGES IN ENVIRONMENT [1]

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Between November 1950 and May 1952 several workers *(1)* reported that the feeding of aureomycin to young calves exerts a favorable influence on their growth and well-being. Later reports also have indicated that aureomycin feeding favorably influences calf growth *(2, 5, 6, 8, 9, 11, 12, 13, 14, 16, 18)* and reduces the incidence of scours *(12)*.

In an earlier experiment conducted at the Kansas Station *(1)* the calves were raised in a barn used for this purpose for 18 years and in which the incidence of scours and colds and associated death losses had been considered extremely high. Under these unfavorable conditions, aureomycin feeding to 12 weeks of age resulted in a 43% gain in weight and markedly reduced the incidence of scours and colds. The experiment reported herein was initiated to determine what beneficial effect, if any, aureomycin would have on calves raised under more favorable conditions. Also, in order to obtain more information on the importance of the amount of aureomycin fed, two levels were compared in this study.

## EXPERIMENTAL PROCEDURE

Thirty Holstein and Jersey calves were divided randomly by breed and sex into three groups. Every group contained three females and two males of each breed. Calves in one group (controls) received a basal ration only. Calves in the second group received, in addition to the basal ration, Lederle's Aurofac in amounts calculated to supply 15 mg. of aureomycin daily for each 100 lb. of calf weight. Calves in the third group were fed like those in the second group except that the level of aureomycin was increased to 45 mg. Aurofac was ingested once daily by capsule for the first 16 weeks and thereafter added once daily to the grain ration. The calves were started on experiment when 4 days old and were kept on experiment until 25 weeks of age. The majority of calves was from the Kansas State College dairy herd. A few were borrowed from a breeder of purebred Jerseys. These calves were brought to the College after they had been with their dams for 3 days.

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All calves received their mother's colostrum for the first 3 days. On the fourth day they were placed in individual pens and fed whole milk at the daily rate of 1 lb. per 10 lb. body weight. At the end of the third week they were gradually changed over to skimmilk, which was fed at the daily rate of 1 lb. per 10 lb. body weight, not to exceed 14 lb. daily. Good quality alfalfa hay and a grain mixture (equal parts by weight of whole corn and oats) were fed ad libitum beginning at 1 week of age. When 12 weeks of age, the animals were changed from the corn and oats mixture to a calf grower ration consisting of 200 parts by weight of corn, 200 of oats, 200 of wheat bran, 175 of soybean oil meal, 6 of salt, and 6 of bone meal. The daily grain intake was limited to a maximum of 4 lb. for Jerseys and 5 lb. for Holsteins. The calves were weaned from skimmilk at the end of the 16th week.

The calves were weighed at weekly intervals. Records were kept of all feed consumed. Daily health records were kept. If a calf had scours, a cold, or other infection, accompanied by fever, it was treated by a member of the College veterinary staff. Treatment usually consisted of the administration of either penicillin (intra-muscularly) or sulfa drugs (per os). When calves had scours but no rise in body temperature, treatment consisted only of reducing the amount of milk normally fed for the next one or two feedings.

The barn used for the main part of this study had a new dirt floor and new calf pens. The year prior to the initiation of this experiment it had housed dairy bulls. After the start of the experiment all calves born in the College herd were placed in this barn after being removed from their dams, thus minimizing the chances of transmitting infection from young calves being raised in one barn to those in another. At the end of the 16th week of age the animals were moved to the old calf barn, where they were housed for the remainder of the experiment.

## RESULTS

The effects of aureomycin on calf health are presented in Table 1. Diarrhea, pneumonia, and undiagnosed infections, when accompanied by a fever and requiring medication, were classified as severe. Infections not accompanied by a fever were classified as mild. The designation of medium was given to infections that could not readily be classified as mild or severe. It appears that the 45 mg. level of aureomycin feeding is more effective than the 15 mg. level in controlling the types of infections encountered during this experiment.

TABLE 1

*Effect of different levels of aureomycin feeding on total number of infections in Jersey and Holstein calves from 1 to 25 weeks of age*

| Amt. of aureomycin fed/100 lb. wt. daily | Degree of infection and no. of observations | | | | | |
|---|---|---|---|---|---|---|
| | Severe | | Medium | | Mild | |
| | Jersey | Holstein | Jersey | Holstein | Jersey | Holstein |
| None (control) | 5 | 0 | 4 | 2 | 8 | 5 |
| 15 mg. | 1 | 1 | 5 | 0 | 1 | 3 |
| 45 mg. | 1 | 0 | 2 | 0 | 3 | 1 |

Except for one outbreak of disease (not specifically diagnosed but thought to be hemorrhagic septicemia-like) which occurred midway during the trial and resulted in the majority of severe infections encountered in this study, sickness was not as great a problem as in the first calf experiment *(1)* conducted in the old calf barn. Although in that experiment aureomycin feeding appeared effective in preventing severe types of scours and colds, it is obvious from the data in Table 1 that low levels of aureomycin feeding will not always prevent certain types of severe infections. However, it appeared that the aureomycin-fed calves responded to treatment better and recovered sooner from severe infections than did the control calves.

The effect of aureomycin on growth is shown in Figure 1 and Table 2. The average weight at 25 weeks of age was 349% of the average first week's weight for calves receiving 45 mg. of aureomycin, and 314% for those receiving 15 mg. of aureomycin. For the same period, the control calves averaged 291% of their

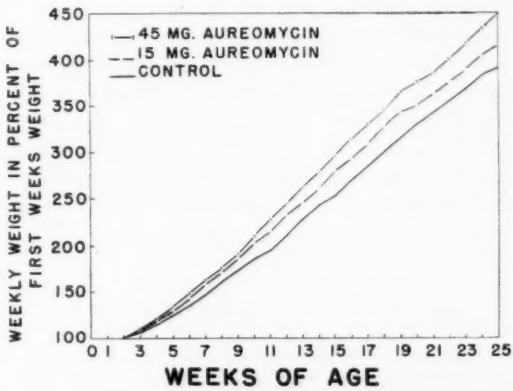


FIG. 1. Comparative growth response of two groups of calves receiving either 15 or 45 mg. of aureomycin (Lederle's Aurofac) daily per 100 lb. body weight from 1 to 25 weeks of age, and of control calves.

TABLE 2

*Effect of different levels of aureomycin feeding on the growth rate of calves*

| Amt. aureomycin fed/100 lb. wt. daily | No. of calves | 25th week's wt. in % of 1st week's wt. | Regression coefficient, $b$ | $C_1I_{35}$ on $(\beta i - \beta j)$[a] | Estimated increase in growth rate *(b)* due to increased aureomycin intake |
|---|---|---|---|---|---|
| 45 mg. | 10 | 349 | 15.66 * * *[b] | $1.0 \leq \beta_{45} - \beta_{15} \leq 1.8$ | (%) 7 to 12 |
| 15 mg. | 10 | 314 | 14.30 * * * | $0.5 \leq \beta_{15} - \beta_{c} \leq 1.5$ | 4 to 11 |
| None (control) | 10 | 291 | 13.29 | | |

[a] $\beta$'s are the population parameters estimated by the $b$'s.
[b] * * * = difference siginifieant at 0.1% level.

first week's weight. A statistical analysis revealed that when both breeds and both sexes are considered and growth rate is measured by the linear regression of weight per pound of first week's weight on age, the calves receiving 15 mg. of aureomycin grew at a significantly faster rate than the control calves (Table 2). Also, the calves receiving 45 mg. grew at a significantly faster rate than those receiving 15 mg. However, the growth rate did not increase in proportion to the increased aureomycin intake. When the regression coefficient $b$ is employed as the estimate of growth rate and the data are reexpressed by means of 95% confidence intervals (Table 2), the growth rate of the calves receiving 15 mg. of aureomycin is estimated to be 4 to 11% above the growth rate of the control calves, and the growth rate of the calves receiving 45 mg. is 7 to 12% above those receiving 15 mg.

Differences between males and females with respect to treatments were analyzed (Table 3). One male calf in the group receiving 15 mg. of aureomycin was unthrifty and made an abnormally small gain. Since this calf represented one-fourth of the animals in this group, a statistical analysis comparing sexes in this group was not made. In the control group the growth rate of the male calves was estimated to be 13 to 23% above the growth of the females, whereas in the group receiving 45 mg. of aureomycin the growth rate of the males was only 3 to 11% above that of the females. It would appear, therefore, that the natural difference in growth rate between males and females is reduced, relatively, by the addition of aureomycin to the diet. Since the number of calves of one sex within each treatment group is small, the data should be interpreted with caution.

TABLE 3

*Growth rates of male and female calves as affected by different levels of auromycin feeding*

| Amt. aureomycin fed/100 lb. wt. daily | Sex | No. of calves | 25th week's wt. in % of 1st week's wt. | Regression coefficient, $b$ | C $I_{95}$ on difference[a] | Difference as % of females |
|---|---|---|---|---|---|---|
| 45 mg. | Male | 4 | 369 | 16.04 * * *[b] | $0.5 \leq \beta\sigma^{\prime} - \beta\varphi \leq 1.7$ | 3 to 11 |
| | Female | 6 | 336 | 14.93 | | |
| 15 mg. | Male | 4 | 295 | [c] | | |
| | Female | 6 | 327 | | | |
| None (control) | Male | 4 | 318 | 14.59 * * * | $1.6 \leq \beta\sigma^{\prime} - \beta\varphi \leq 2.8$ | 13 to 23 |
| | Female | 6 | 270 | 12.40 | | |

[a] $\beta$'s are the population parameters estimated by the $b$'s.
[b] * * * = difference significant at 0.1% level.
[c] Analysis not made because 1 male calf abnormal.

It is apparent from statistical analysis of the data presented in Table 4 that the two breeds do not respond in the same manner to the two levels of aureomycin. In both sexes in the Holstein breed, calves receiving 15 mg. of aureomycin grew at a significantly faster rate from 1 to 25 weeks of age than did the control calves. For the same period Holsteins receiving 45 mg. failed to show any advantage over the controls. In the Jersey breed a different situation exists. The 45 mg.

level appears to be more effective than the 15 mg. level. Also, the differences in growth rate between Holstein males and females for all treatments are not significant, whereas the reverse is true with Jerseys.

TABLE 4

*Variations in growth rate between sexes within breeds possibly associated with the feeding of different levels of aureomycin*

| | | Av. wt. at 25th wk. in % of av. at 1st wk. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Holstein | | | Jersey | | |
| Sex | No. of calves per treatment | Control | 15 mg. aureo. | 45 mg. aureo. | Control | 15 mg. aureo. | 45 mg. aureo. |
| Male | 2 | 307 | 350 | 300 | 328 | 241 | 438 |
| Female | 3 | 298 | 337 | 295 | 242 | 316 | 377 |
| | | Regression coefficients. *b* | | | | | |
| | | ns[a] | | | * * * | | |
| Male | 2 | 13.29 * * *[b] | 15.72 * * * | 13.06 | 15.90 | . . . . .[d] | 20.44 |
| | | ns | ns | ns | * *[c] | | * * * |
| Female | 3 | 13.46 * * * | 14.87 * * * | 12.95 | 11.34 * * * | 14.53 * * * | 16.89 |
| | | ns | | | | | |

[a] ns = difference not significant.
[b] * * * = difference significant at the 0.1% level.
[c] * * = difference significant at the 1% level.
[d] Analysis not made because 1 male calf abnormal.

Possibly, apparent differences in response between the two breeds to the two levels of aureomycin are due to a greater susceptibility of Jersey calves to infection (Table 1), thus requiring a large amount of aureomycin for disease control. Also, it is possible that since Holsteins received considerably more aureomycin per calf than did Jerseys, 45 mg. for each 100 lb. of weight is an excessive intake for Holsteins and is in some manner detrimental. This possibility is supported by graphical analysis of the data (not presented and not analyzed statistically), which shows that Holsteins receiving 45 mg. of aureomycin grew as rapidly from 1 to 10 weeks as those receiving 15 mg. However, after 10 weeks the calves receiving 45 mg. of aureomycin grew only as rapidly as the control calves, whereas those receiving 15 mg. grew at a faster rate than the control calves. Since the rumen has started to function by 10 weeks of age, some effect on rumen function due to an excessive aureomycin intake may be conjectured. Murley *et al. (12)* and Jacobson *et al. (8)* noted that Jerseys appear to exhibit a greater response to aureomycin feeding (80 mg. per calf daily) than do Holsteins. Rusoff *et al. (15)* fed Jersey and Holstein calves either 75 to 150 mg. aureomycin HCl daily by capsule or aureomycin via a calf starter containing 2% Aurofac. The calves receiving aureomycin in the latter manner apparently obtained considerably less aureomycin per day than the calves fed aureomycin by capsule. These investigators noted that there was a slightly greater growth response to aureomycin in the Jerseys than in the Holsteins. On further study of their data, it may be noted that the Holstein calves receiving the lower level

of aureomycin grew at a slightly faster rate than those receiving the higher level. The reverse was true of the Jerseys. These reports tend to support our findings.

Data (not analyzed statistically) on the effect of aureomycin on average daily gain by intervals of 4 weeks are presented in Table 5. From 1 to 13 weeks of age, the calves receiving 45 mg. of aureomycin per 100 lb. of body weight daily made average daily gains that were greater than the gains made by calves re-

TABLE 5

*Effect of different levels of aureomycin feeding on gain in weight of calves by 4-week intervals*[a]

| Amt. aureomycin fed/100 lb. wt. daily | No. of calves | 4-week intervals | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2-5 | 6-9 | 10-13 | 14-17 | 18-21 | 22-25 |
| | | Av. daily gain *(lb.)* | | | | | |
| 45 mg. | 10 | 0.88 | 1.68 | 1.71 | 1.63 | 1.35 | 1.76 |
| 15 mg. | 10 | 0.81 | 1.45 | 1.54 | 1.65 | 1.38 | 1.41 |
| None (control) | 10 | 0.65 | 1.25 | 1.41 | 1.51 | 1.42 | 1.33 |
| | | Av. daily gain of aureomycin-fed calves above av. daily gain of control calves (%) | | | | | |
| 45 mg. | | 35.0 | 34.0 | 21.2 | 7.9 | −5.2 | 32.3 |
| 15 mg. | | 25.0 | 16.0 | 9.2 | 9.3 | −2.8 | 6.0 |

[a] Data as presented in this table were not tested for statistical significance.

ceiving 15 mg. of aureomycin. For the same period the calves receiving 15 mg. of aureomycin made greater average gains than those receiving none. Beyond 13 weeks, the decrease in growth coinciding with the decrease in level of aureomycin feeding was not so consistent. By expressing the average daily gain of the aureomycin-fed calves as a percentage of the average daily gain of the control calves, the response to aureomycin (Table 5) was greatest during the first 5 weeks of life and gradually diminished as the calves grew older. The exception to this was the period from 21 to 25 weeks, when for no accountable reason the gains of the calves fed aureomycin were considerably better than the gains of the control calves.

The effects of the different levels of aureomycin feeding on the average weekly intake of skimmilk, hay, and grain are shown in Table 6. The feed intakes were studied for the period from 1 to 16 weeks inclusive. For purposes of comparison, the intakes are expressed on an equal weight basis, computed by determining the geometric mean weight for each calf and using it to convert the average weekly feed intake to a 100-lb. body weight basis. Since whole milk was fed on a body weight basis, the milk intake was not studied. The control calves consumed an average of 3.7 lb. of hay per week, whereas the calves receiving 45 mg. of aureomycin averaged 5.1 lb., or 38% more than the controls. The calves receiving 15 mg. of aureomycin averaged 4.4 lb. of hay per week, or 19% more than the control calves. An analysis of variance of the data showed that none of these differences were statistically significant. The differences in grain intake

were not so great as the differences in hay consumption. The control calves consumed an average of 10.9 lb. of grain per week, and the calves receiving 45 mg. of aureomycin averaged 11.7 lb., or 7% more, and the calves receiving 15 mg. averaged 11.0 lb., or 1% more than the control calves. The skimmilk intakes were similar for the three groups. An analysis of variance of these data showed that the consumption of grain and skimmilk was not affected seriously by the addition of 15 or 45 mg. of aureomycin to the diet.

Although the calves receiving 45 and 15 mg. of aureomycin used less total digestible nutrients and less digestible protein per pound of gain than the control calves (Table 6), an analysis of variance of the data showed that these differences were not significant, since they were minor compared to the sampling error.

TABLE 6

*The effect of different levels of aureomycin on feed intake and efficiency of gain of calves from 1 through 16 weeks of age*[a]

| Amt. aureomycin fed/100 lb. wt. daily | No. of calves | Av. weekly intake/calf /100 lb. body wt. | | | TDN /lb. gain | Dig. protein /lb. gain |
|---|---|---|---|---|---|---|
| | | Skimmilk | Hay | Grain | | |
| | | *(lb.)* | *(lb.)* | *(lb.)* | *(lb.)* | *(lb.)* |
| 45 mg. | 10 | 39.4 | 5.1 | 11.7 | 2.16 | 0.41 |
| 15 mg. | 10 | 40.3 | 4.4 | 11.0 | 2.16 | 0.42 |
| None (control) | 10 | 40.6 | 3.7 | 10.9 | 2.23 | 0.44 |

[a] None of these differences was statistically significant.

## DISCUSSION

In an earlier experiment *(1)* conducted in old quarters, calves receiving 15 mg. of aureomycin per 100 lb. body weight daily averaged, at the end of 12 weeks, 228% of birth weight, whereas the control calves averaged 190%. In the present experiment conducted in new quarters, the control calves averaged, at the end of 12 weeks, 228% of their first week's weight; calves receiving 15 mg. of aureomycin averaged 246%, and calves receiving 45 mg. averaged 255%. It is apparent that the control calves in the second experiment grew at a faster rate than the controls and as well as the aureomycin-fed calves of the first experiment. Even though the conditions were more favorable in the second experiment, as evidenced by a lower incidence of disease and the superior growth of the control calves, 15 and 45 mg. levels of aureomycin significantly increased growth rate.

Several workers *(3, 4, 7, 10)* have shown that antibiotics have little or no effect on growth of chicks raised in an environment previously unoccupied by chicks. Chicks fed no antibiotics in new quarters grew as well as, or more rapidly than, those fed antibiotics in old quarters. The antibiotic effect was thought to be due to the suppression of an infection, not grossly manifested but nevertheless present in the birds raised in old quarters. The results of this study with calves support the results of the above mentioned studies with chicks in that the con-

trol calves in the new quarters grew as rapidly as the aureomycin-fed calves in the old quarters, but disagree in that the aureomycin-fed calves in the new quarters grew at a significantly faster rate than their controls.

This investigation was undertaken before the chick experiments were reported, and the authors were not fully aware of the importance of the effect of environment. Therefore, the experiment was not designed to control the environment as carefully as it was controlled in the chick experiments, and several explanations may be offered as to why the calves responded to aureomycin in the new barn. The "disease level" (recognized in pigs for some time by Speer *et al., 17)* was probably higher in the calves raised in new quarters than in the chicks raised in new quarters. The calves remained with their dams for 3 days in a maternity barn and could have been exposed to infection at this time. Several calves were borrowed from a purebred Jersey breeder, who allowed them to remain with their dams for 3 days before sending them to the College. Also, controlling a "new environment" for calves may be more difficult than in the case of chicks. Calf experiments are generally of longer duration than chick experiments, and, since calves are usually added to the experiment as they are born in the herd, several months may elapse before the experiment is completed. It is not improbable that during this time the barn could become contaminated with undesirable organisms. In fact, Hill *et al. (7)* reported that at 3 weeks a growth response in chicks to penicillin was evident in old quarters, but not in new. After 3 weeks the birds in new quarters showed a small growth response, which the authors thought could be attributed to a gradual contamination of the new quarters.

The important implication of these calf experiments is the indication that even when conditions are not particularly unfavorable, aureomycin will enhance calf growth and suppress infection. From a practical viewpoint it is difficult to visualize many large dairy farms where the calf quarters would remain uncontaminated for long periods of time, unless a rotation system was used.

## SUMMARY

Thirty Holstein and Jersey calves 4 days old were divided randomly by breed and sex into three groups. Calves in one group (control) received a basal ration only; calves in the second group received, in addition, Lederle's Aurofac in amounts calculated to supply 15 mg. of aureomycin daily per 100 lb. weight; calves in the third group received 45 mg. of aureomycin per 100 lb. weight. The experiment was conducted in a barn that had not housed calves previously, and the results were compared with those of an experiment in which the calves were fed a 15 mg. level of aureomycin and raised in an old barn that had proved unfavorable for calf raising.

In the new quarters, in which sickness was not as great a problem, both levels of aureomycin feeding reduced the incidence of infection. Calves fed no aureomycin in the new quarters grew as rapidly as calves fed aureomycin in the old quarters. However, aureomycin-fed calves in the new quarters grew at a significantly faster rate than the control animals.

It was found that the 45-mg. level of aureomycin was more effective than the 15-mg. level in controlling the types of infections encountered. During the period of 1 to 25 weeks of age, average growth rate of both breeds considered together was increased significantly by the 15-mg. level of aureomycin feeding. Another statistically significant increase resulted when the level of aureomycin was increased to 45 mg., but the growth rate was not in proportion to the increased aureomycin. In the Jersey breed the 45-mg. level of feeding was more effective than the 15-mg. level, but in the Holsteins 15 mg. was the more effective. Holstein calves receiving 45 mg. failed to show any growth advantage over the control calves.

For the period of 1 to 16 weeks, calves receiving 15 mg. of aureomycin consumed 19% more hay, and those receiving 45 mg. consumed 38% more, than the controls. These differences were not statistically significant. The differences in grain intake followed the same trend but were not as great and also were not significantly different. The calves receiving 45 and 15 mg. of aureomycin used less total digestible nutrients and less digestible protein per pound of gain than the control calves. These differences were not statistically significant.

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# OBSERVATIONS OF DAIRY COW ACTIVITIES IN LOOSE-HOUSING [1]

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Many dairymen are turning to the loose-housing system of herd management as a way of obtaining more efficient and economical milk production. The experiences of these farmers have shown that proper management practices, as well as suitable barn and lot arrangement, determine the success or failure of the system.

The Michigan State College Brown Swiss herd has been maintained under loose-housing conditions for the past 2 years. The lounge barn has straw storage in one end and a milking room and milk house in the other. Hay is self-fed from a storage barn which bounds the west side of the paved lot, and a self-feeding silo is located at the south end of the paved area opposite the lounge barn.

Although this plan allows efficient operation of the herd from a labor standpoint, there has been little information available as to its desirability in certain other respects. In the first place, the effect of weather conditions on eating time when the roughage feeding areas are exposed to the elements has not been thoroughly studied. The effect on hay consumption of allowing continuous access to silage also is unknown. The amount of roughage consumed when self-fed and its relation to the concentrate feeding program have not been studied under these conditions. The economy of such a feeding program is not known. Space requirements for roughage storage and lounge area have been frequently revised and often are based on engineers' opinions and estimates, which may vary widely from the actual needs. Bedding is often a critical item in loose-housing, yet little information on improving the efficiency of its utilization can be found.

As the initial step in studying some of these problems, it was believed that an examination of the behavior and habits of dairy cattle in loose-housing would provide valuable leads for future work. This report, therefore, is concerned with the factors which influence the activities of dairy cattle in loose-housing.

## METHODS AND MATERIALS

A series of six 24-hour observations of the activities of a herd of 20 (reduced to 19 after the third observation period) Brown Swiss cows maintained in a quonset-type steel loose-housing barn located on the Michigan State College

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farm was made between November 1, 1952, and March 30, 1953. The first 24-hour period was obtained by combining three 8-hour observations on November 1, 3, and 8. The subsequent observations covered 24 consecutive hours. During these periods a check of the location and activity of each cow was made at 10-minute intervals. The activities were divided into four groups: eating silage and hay, loitering in the yard and lounge, resting in the yard and lounge areas, and milking time.

The cows had free access to a self-feeding upright silo containing corn silage, at the south end of the paved lot, during the first three observations. After January 10, 1953, no silage was fed. The cows had continuous access to hay.

Concentrates were fed in the milking room to cows in lactation, whereas dry cows were fed from a trough located in the paved lot. Milking started at 5 A.M. and 5 P.M.

In addition, 18 weekly determinations of rectal temperature, pulse rate, and respiration rate were made on the cows between November 11, 1952, and March 25, 1953. For comparative purposes similar measurements were made on six Holstein cows housed in the College stanchion dairy barn.

Weather data, including air temperature in the paved lot and lounge areas, were obtained with continuous recording instruments. Lounge temperature was taken at a height of about 8 ft. above the manure pack. No temperature records were kept in the stall barn. Data on wind velocity and precipitation were taken from records of the United States Weather Bureau at East Lansing.

## RESULTS AND DISCUSSION

*Silage and hay consumption.* The pertinent climatic data and average daily time spent by each cow at these activities are shown in Table 1. While they had silage, the 20 cows averaged 4.2 hours a day at the silo. Even though the

TABLE 1

*Climatic conditions and hours spent at various activities during six 24-hour observations of Brown Swiss cows in loose-housing*

| | Date | | | | | |
|---|---|---|---|---|---|---|
| | Nov. | | Dec. | Jan. | Feb. | Mar. |
| | 1, 3, 8 | 28-29 | 30-31 | 23-24 | 27-28 | 29-30 |
| *Climatic* | | | | | | |
| Yard temp. *(Av. ° F.)* | 42 | 22 | 30 | 32 | 30 | 37 |
| Precipitation *(Total in.)* | 0 | 0.02 | 0.02 | 0.39 | 0.05 | 0.01 |
| Wind *(Av. mph.)* | 9.5 | 15.5 | 11.1 | 14.2 | 20.3 | 17.9 |
| *Activities (Total hr.)* | | | | | | |
| Eating hay | 0.7 | 0.9 | 2.6 [a] | 4.7 | 5.4 | 5.1 |
| Eating silage | 4.7 | 4.1 | 4.0 | —— [b] | —— | —— |
| Yard loitering | 5.3 | 4.1 | 5.8 | 1.9 | 3.9 | 2.2 |
| Lounge loitering | 3.0 | 6.1 | 4.0 | 5.2 | 4.0 | 6.1 |
| Yard resting | 1.0 | 0.2 | 0.2 | —— | —— | —— |
| Lounge resting | 9.2 | 8.3 | 7.1 | 11.7 | 10.2 | 10.2 |
| Milking | 0.1 | 0.3 | 0.3 | 0.5 | 0.5 | 0.4 |

[a] Silage not available during evening.
[b] No silage fed after Jan. 10, 1953.

cows were eating from a tightly compacted pillar of silage, this amount of time was not excessive. Porter *(2)* has reported that cows spent over 3 hours between 7 A.M. and 5:30 P.M. eating loose silage from a bunk.

The time spent eating hay was affected markedly by the availability of silage. When silage was available, the cows spent less than an hour daily eating hay. However, after the silo was emptied, early in January, the cows spent more than 5 hours daily at the hay feeders. The feeding of silage had no effect on the total time spent eating roughage, which averaged 5.2 hours daily.

It will be observed that roughage eating was distributed throughout the day (Figure 1). Peak consumption of both hay and silage took place from 8 to 11 A.M. with relatively heavy consumption continuing until about 8 P.M.

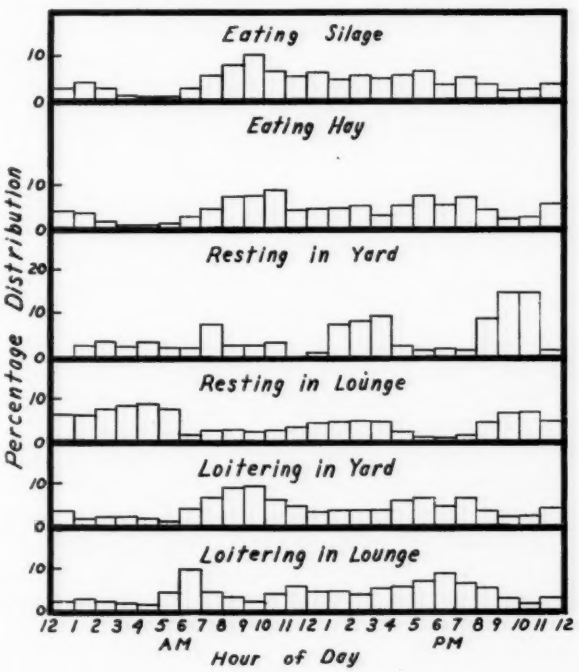


FIG. 1. The hourly distribution of daily time at each activity expressed as per cent of the total time. (For example, the cows averaged 4.2 hours daily eating silage and 2.3% of this time was spent between 12 and 1 A.M.)

However, the cows ate 22.5 and 22.4 % of their daily hay and silage, respectively, between the hours of 8 P.M. and 3 A.M. Very little roughage was eaten between 3 and 6 A.M.

Although no actual determinations were made of the pounds of hay and silage consumed, our observations have led us to believe that the cows ate somewhat more than they would have eaten under barn-feeding conditions. This

observation is in accord with the belief among farmers with loose-housing barns and the reports of Brown and coworkers *(1)* and Witzel and associates *(4)* that roughage consumption is greater under loose-housing conditions than in stall barns. This implies, too, that storage facilities must be greater under a self-feeding program.

Since once a day roughage feeding is recommended for loose-housing barns which do not permit self-feeding, it appears from these data that roughage should be distributed soon after the morning milking. However, if labor is not critical, consumption of either hay or silage could be increased by supplying fresh feed after the evening milking.

From the observed preference of the cows for silage, the question of the economy of allowing continuous access to each may be raised. Silage is usually a more expensive feed than hay, and unless its greater use results in higher production or allows economies in concentrate feeding, the program would not be as economical as one in which silage was limited. In this study, production was not affected by the loss of silage to the ration. The effect of self-feeding these roughages on concentrate feeding rates will be the subject of a future investigation.

*Loitering in the yard and lounge.* In the absence of storms, the availability of silage appeared to exert more influence on the amount of loitering in the paved yard than any other one factor. The cows spent an average of 5.1 hours daily loitering in the yard while silage was available, but only 2.7 hours when hay was the only roughage. The time spent loitering in the lounge and total loitering time were also related to silage feeding. During the first three observation periods, the cows averaged 4.3 hours daily loitering in the lounge and 9.4 hours total loitering time. Comparable figures for the last three periods were 5.1 and 7.8 hours daily, respectively.

Yard loitering increased markedly after 6 A.M. (Figure 1), as the cows went into the yard after being milked, and reached a peak between 9 and 10 A.M., when roughage consumption was high. Again, the yard loitering increased between 4 and 8 P.M. While they had access to silage, some cows could be seen loitering in the yard at any hour. The amount of night loitering decreased when hay alone was supplied and rarely was observed between midnight and daybreak.

The amount of loitering in the lounge increased between 5 and 6 A.M. as the cows waited to be milked. After 9 A.M., loitering in the lounge tended to show a gradual increase until 7 P.M., after which it declined to a relatively low level for the rest of the night.

The large amount of daytime loitering in the lounge is a definite factor in the economical use of bedding and the maintenance of a clean herd. If the lounge area had been freshly bedded in the morning, the clean straw would have been thoroughly trampled by nightfall. The cows could have been kept clean only by giving the area a second bedding at night. On the other hand, by bedding the lounge after the evening milking, the cows had a clean bed for the night and the straw was relatively untrampled in the morning. There was enough straw left to withstand the day's trampling nearly as well as if it had

been distributed in the morning. By following the practice recommended here, bedding consumption in this barn averaged 8.2 lb. of chopped straw daily per cow. This is little more than is required by a cow in a properly bedded stanchion barn.

*Resting in yard and lounge.* The amount of time spent lying in the yard was insignificant (Table 1). During the first three observations, cows were seen occasionally lying in front of the hay feeders. None was observed resting in the yard after the silage was gone. The total amount of resting also was related to the feeding of silage. During the first three periods, the cows spent an average of 8.2 hours daily lying down, primarily in the lounge area. While hay was the only roughage, the time increased to 10.7 hours daily.

Although most of the daily resting time was spent between 8 P.M. and 6 A.M., a significant amount was observed during the day. After 7 A.M. the amount of resting in the lounge increased, and 20% of the daily resting occurred between noon and 4 P.M.

*Milking time.* The seemingly large amount of time required for milking as shown in Table 1 is misleading. Observations based on 10-minute intervals are not accurate enough to show the exact time in the milking room. The increased milking time shown for December and later months can be accounted for by changes in the number of cows milked, since nine of the cows calved during the time covered by these observations.

*Effect of weather.* The winter of 1952-53 was relatively mild, and the usual temperature extremes did not occur. The temperature in the lounge area at a height of about 8 ft. over the manure pack ranged from 2 to 8° F. above that in the yard.

During the 24-hour observation periods and at the time of weekly determinations of rectal temperatures, respiration and pulse rates, it was noted that low temperatures alone had little or no effect on the activity of the cows. Even on stormy days the time spent eating was not affected materially, although yard loitering was reduced markedly. These observations agree with those of Smith and coworkers *(3)* and indicate that dairymen need not be concerned about the effect of cold or moderately stormy weather on outside self-feeding of roughage.

That cows do make certain physiological adjustments to the exposure experienced in loose-housing is indicated in Figure 2. The rectal temperatures, pulse and respiration rates of six Holstein cows in a stanchion barn were compared with those of the Brown Swiss at weekly intervals. Although the animals in the two groups were not entirely comparable as to breed, age, and stage of lactation, changes in the differences between the groups were probably due to environment.

For the first 4 weeks of this investigation, the rectal temperatures of the cows in the two groups were similar, both averaging 101.4° F. After the fourth week, the temperatures of the Brown Swiss tended to be lower than those of the Holsteins. The average temperatures for the entire period were 101.4 and 101.1° F. for the cattle in stall and loose-housing, respectively. Statistically these differences were significant at the 1% level.

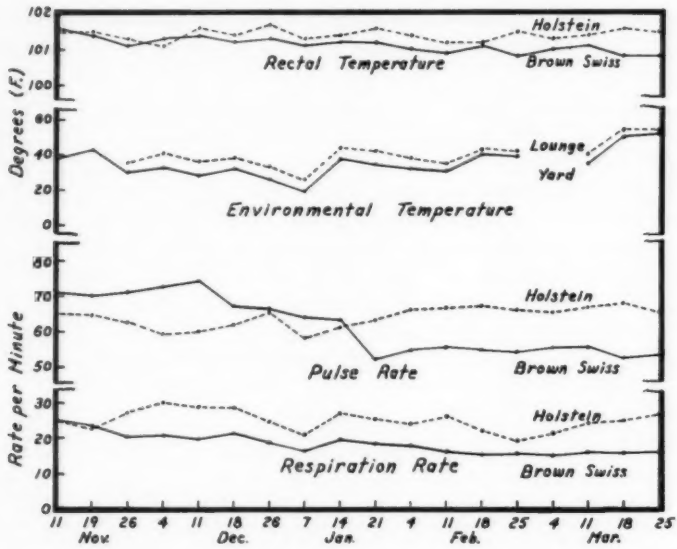


FIG. 2. Rectal temperature, pulse rate, and respiration rate of Holstein cows in a stanchion barn and Brown Swiss cows in loose-housing with the yard and lounge temperatures of the loose-housing barn.

The average pulse rate of the cows in loose-housing was higher than that of those in the stanchion barn for the first 9 weeks. After that time the rate of the Brown Swiss fell below that of the Holsteins. The average rates for the two groups were significantly different when the two periods were considered separately. The average rates for the two periods were 62.0 and 66.1 beats per minute in the stanchion barn and 68.8 and 54.7 in the loose-housing barn.

After the second week, the respiration rate of the Brown Swiss was also significantly lower than that of the cows in the stanchion barns. The rates were statistically significantly different and averaged 18.3 and 25.0 respirations per minute, respectively.

Although the lower rectal temperatures and respiration rates and the observed changes in pulse rate of the cows in loose-housing probably reflect metabolic adjustments to the colder environment, a plotting of regression lines showed that there was too much individual variation to support the drawing of any conclusions regarding the relation of environmental temperature to these determinations.

## SUMMARY

The activity patterns of a herd of Brown Swiss cows wintered in a loose-housing barn with outside self-feeding of hay and silage are described. When the cows had access to silage, they spent an average of 5.2 hours daily eating,

5.1 hours loitering in the yard, 4.3 hours loitering in the lounge, and 8.2 hours resting. When hay alone was available, the eating time remained unchanged, but the cows spent 2.7 hours daily loitering in the yard, 5.1 hours loitering in the lounge, and 10.7 hours resting.

Eighteen weekly determinations of the rectal temperatures, pulse, and respiration rates of six Holstein cows in a stanchion barn were compared with those of Brown Swiss Cows. The rectal temperatures and respiration rates of the Brown Swiss were significantly lower than the average of the Holsteins. The average pulse rate of the Brown Swiss was significantly higher than that of the Holsteins for the first 9 weeks. During the second 9 weeks the Brown Swiss pulse rate was significantly lower than that of the cows in the stanchion barn. These measurements could not be correlated with changes in environmental temperature.

ACKNOWLEDGMENTS

The authors are indebted to B. F. Cargill of the Michigan State College Department of Agricultural Engineering, who provided the climatic data, and to N. P. Ralston of the Dairy Department for his cooperation in providing facilities for this work.

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# EFFECTS OF VACUUM LEVEL AND MILKING DURATION ON MILK PRODUCTION, MILKING TIME AND RATE OF MILK FLOW IN MASTITIS-FREE FIRST CALF HEIFERS[1]

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Attempts to maximize the efficiency of milking have resulted in several experiments dealing with factors influencing this procedure. According to Smith and Petersen *(11)*, increasing the vacuum level from 10 to 12 and 14 in. of mercury resulted in a nonlinear increase in the rate of milking. This increase was postulated as being due to the differences in the opening of the teat meatus with increased negative pressure. Baxter *et al. (2)* in a short-term experiment using vacuums of 11, 16, and 20 in. of mercury found an increase in the peak rate of flow with an increase in vacuum. By cannulation of the teat, differences between quarters became nonsignificant, indicating that the teat orifice is one of the main factors controlling milk flow. At the higher vacuum levels, increased amounts of strippings were necessitated, apparently caused by teat cup crawling. Whittleston *(13)*, however, reported no significant increase in rate of milking when vacuums as high as 19 in. of mercury were used.

Dodd and Foot *(7)* subjected first calf heifers for a complete lactation to a milking duration of either 4 or 8 minutes. Although no significant differences in the milking rates and 305-day lactation yields were reported, a difference in fat percentage was obtained, the 4-minute group testing lower.

It was the objective of this experiment to investigate for a complete lactation the effect of different vacuum levels and milking durations on milk production and milking characteristics in mastitis-free first calf heifers.

## EXPERIMENTAL

*Animals and treatments.* Twelve first calf heifers, nine Holsteins and three Jerseys, from the University herd and four other herds were used in this experiment. Each heifer was subjected for the first month postpartum to a standardizing period during which she was milked at 13 in. of vacuum and for

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a normal duration. Upon completion of this standardizing period, the heifers were randomly assigned within replicates to be milked at a vacuum level of 10, 13, or 17 in. of mercury from the fifth through the forty-fourth week of lactation. Halves of udders were milked separately with goat-claw bucket-type milkers to allow milking for two different durations. The halves were assigned at random to a milking duration for the first and third replicates, and the opposite halves for the second and fourth replicates were assigned to the same milking duration. This was done to insure an even number of right and left halves being milked at each duration. The durations used were "normal" and "twice normal." On the first 2 days of each experimental week, normal milking duration was determined *(8)* by suspending each milker unit from a dairy scale and recording, with the aid of a stop watch, the length of time required for the milk flow to fall to 0.1 lb. or less in a 15-second interval *(2)*. The twice normal halves had the machines left on for twice their own normal milking duration. Before milking, each heifer was stimulated for let down by a 30-second udder massage and by using a strip cup.

The details of feeding and milking were reported in a previous paper from this station *(10)* dealing with the effects of vacuum level and milking duration on udder health in the same mastitis-free first calf heifers.

*Observations.* Total milk yield to the nearest 0.1 lb. was recorded for individual half udders of each cow at each milking. The values used in the statistical analyses were obtained by taking the daily average pounds of milk for the third and fourth days of each experimental week. Aliquot milk samples were collected from the A.M. and P.M. milkings for these two days and used for the determination of fat by the Babcock method *(1)*. Average daily pounds of fat were calculated from the results of the Babcock test and the values for milk yield obtained during the sampling period. Per cent of fat was determined by dividing the 2-day fat total by the 2-day milk total. The amount of fat corrected milk (FCM) was derived by use of Gaines' formula *(9)*.

Values for the interquartile range were used to calculate "average rate of flow," an expression intermediate between maximum rate and the over-all average rate of flow. Time to reach peak flow was defined as the time from the application of the machine to the first 15-second interval during which maximum milk yield was obtained. Stripping time was the time required for the operator to machine strip the cow. The amount of strippings was calculated as the difference between the amount obtained in the normal milking time and the total yield for the milking and was expressed as a per cent of total yield.

This design of the experiment was split plot in which the main plot, the cow's udder, was divided into halves so that variation of another factor, duration of milking, could be studied *(5)*.

When accounting for a reduction in variability ($P < 0.05$), adjustment of the values for the comparison period for the averages of the last 2 weeks of the standardizing period was made by the method of covariance *(5)*.

Time trends for the 40 weeks of the comparison period were studied using up to the 3rd degree orthogonal polynomial coefficients *(6)*. Since only the 1st

degree or linear order coefficients showed significant treatment effects, the 2nd and 3rd degree coefficients have not been included in the data presented. The values presented in the tables are arithmetic means plus or minus their standard errors.

## RESULTS AND DISCUSSION

*Vacuum levels.* Average yields and their weekly rates of change expressed as pounds of milk, FCM, per cent of fat, and pounds of fat (Table 1) were not significantly affected by vacuum level. Similar results were obtained by Baxter *et al. (2)*, who found no significant differences in milk yield in a short-term

TABLE 1

*Effect of vacuum levels on milk production of mastitis-free first calf heifers*

| | Vacuum levels | | | | | |
|---|---|---|---|---|---|---|
| | 10″ | | 13″ | | 17″ | |
| Criterion | Standardizing period | Comparison period | Standardizing period | Comparison period | Standardizing period | Comparison period |
| *Lb. of milk* | | | | | | |
| Av. | 18.3 ±1.4 | 13.2 ±0.9 | 19.4 ±1.4 | 15.7 ±1.4 | 16.1 ±1.4 | 12.6 ±0.9 |
| Weekly rate of change *(lb/wk)* | | −0.1800 ±0.0451 | | −0.1686 ±0.0288 | | −0.1439 ±0.0184 |
| *Per cent of fat* | | | | | | |
| Av. | 3.9 ±0.31 | 3.9 ±0.24 | 4.0 ±0.17 | 3.8 ±0.17 | 3.7 ±0.22 | 3.9 ±0.37 |
| Weekly rate of change *(%/wk)* | | +0.0118 ±0.0345 | | +0.0108 ±0.0177 | | +0.0212 ±0.0605 |
| *Lb. of fat* | | | | | | |
| Av. | 0.710 ±0.057 | 0.502 ±0.016 | 0.780 ±0.070 | 0.593 ±0.057 | 0.606 ±0.066 | 0.484 ±0.033 |
| Weekly rate of change *(lb/wk)* | | −0.0053 ±0.1891 | | −0.0047 ±0.0852 | | −0.0034 ±0.0062 |
| *Lb. FCM* | | | | | | |
| Av. | 18.0 ±1.4 | 12.8 ±0.9 | 19.4 ±1.6 | 15.1 ±1.4 | 15.5 ±1.5 | 12.2 ±0.7 |
| Weekly rate of change *(lb/wk)* | | −0.1529 ±0.0465 | | −0.1379 ±0.0232 | | −0.1028 ±0.0145 |

experiment when vacuums as high as 20 in. were used. They did not, however, test other milk production criteria. There appeared to be a tendency (Table 1) for the cows milked at the higher vacuum levels to be more persistent, as evidenced by the slower rates of decrease for pounds of milk, fat, and FCM and also by the more rapid rates of increase for the per cent of fat.

In contrast to milk production, some of the criteria associated with rate of flow (Table 2) were significantly affected by vacuum levels. Average rates of flow appeared to be increased with an increase in vacuum level ($P < 0.10$), and, conversely, the milking time decreased ($P < 0.05$). The increase in rate of

TABLE 2

*Effect of vacuum levels on milking time, rate of flow, time to reach peak flow, stripping time and amount of strippings of mastitis-free first calf heifers*

| Criterion | Vacuum levels | | | | | |
|---|---|---|---|---|---|---|
| | 10″ | | 13″ | | 17″ | |
| | Standardizing period | Comparison period | Standardizing period | Comparison period | Standardizing period | Comparison period |
| Milking time Av. *(sec.)*[a, b] | 508 ±51 | 426 ±45 | 595 ±49 | 422 ±48 | 578 ±30 | 341 ±12 |
| Weekly rate of change *(sec/wk)* | | −3.746 ±0.854 | | −6.056 ±0.884 | | −5.231 ±0.601 |
| Rate of flow Av. *(lb/15 sec.)*[c] | 0.72 ±0.11 | 0.61 ±0.12 | 0.59 ±0.05 | 0.71 ±0.07 | 0.46 ±0.07 | 0.65 ±0.07 |
| Weekly rate of change *(lb/15 sec/wk)* | | −0.0006 ±0.0012 | | +0.0024 ±0.0006 | | +0.0033 ±0.0015 |
| Time to reach peak flow Av. *(sec.)* | 85.8 ±11.3 | 77.4 ±6.6 | 99.1 ±5.7 | 71.3 ±6.0 | 120.3 ±10.3 | 61.8 ±2.5 |
| Weekly rate of change *(sec/wk)* | | −2.3476 ±1.2858 | | −3.5287 ±0.8401 | | −4.2192 ±0.5826 |
| Stripping time Av. *(sec.)* | 178 ±38 | 81 ±34 | 198 ±64 | 57 ±6 | 254 ±48 | 92 ±14 |
| Weekly rate of change *(sec/wk)* | | −1.959 ±1.605 | | −0.171 ±0.299 | | −1.267 ±0.327 |
| Amount of stripping Av. *(% of total yield)*[d] | 7.6 ±2.1 | 13.6 ±2.9 | 6.1 ±1.3 | 8.4 ±1.3 | 15.0 ±4.9 | 16.4 ±2.1 |
| Weekly rate of change *(% of total yield/wk)* | | −0.0764 ±0.1149 | | +0.1357 ±0.0325 | | +0.1071 ±0.0377 |

[a] 10″ *vs.* 13″ ($P < 0.10$).
[b] 10″ *vs.* 17″ ($P < 0.05$).
[c] 10″ *vs.* 17″ ($P < 0.10$)
[d] 10″ + 17″ *vs.* 13″ ($P < 0.10$)

flow with increased vacuum has been reported previously *(2, 11)*, but Whittleston *(13)* reported no such effect.

Since rate of milk flow and milking time have been established to be characteristic of the individual cow *(4, 8)*, it was not surprising to find that the data taken during the comparison were correlated with those taken during the standardizing period. Furthermore, this correlation resulted in a significant reduction in sums of squares for error for these two criteria ($P < 0.05$ for average rate of flow and $P < 0.01$ for milking time). Values for the comparison period adjusted for the standardizing period for rate of flow for the 10, 13, and 17 in. of vacuum were respectively: 0.52, 0.70, and 0.74 lb./15-second interval and for the total daily milking time 475, 391, and 325 seconds. Average time to reach peak flow appeared to decrease with increasing vacuum, but this was found not to be of statistical significance.

A previous report *(2)* indicated that an increase in vacuum from 11 to 20 in. of mercury caused an increase in the stripping time and the amount of strippings; in this experiment, however, neither the stripping time nor amount of strippings expressed as a percentage of milk yield appeared to be directly related to vacuum levels between 10 and 17 in. The 13 in. vacuum appeared to be more efficient for milking since the mean stripping time and mean amount of strippings were both lower for the 13 in. group when compared to the 10 and 17 in. groups ($P < 0.10$ for amount of strippings). Although the effect of high vacuums is in agreement with previous reports, the longer time and greater amount of strippings for the 10 in. group probably were due to the fact that the vacuum was not sufficient with the type of milker used to remove all the milk from some cows.

Although little change was observed in average rate of flow and amount of strippings as lactation progressed, the cows milked at the two higher vacuums increased slightly. The time to reach peak flow decreased more rapidly at the higher vacuum levels; however, none of these time trends were statistically significant.

Use of the split plot design did not permit differences due to the effect of treatment in the main plot, vacuum levels, to be measured with as much sensitivity as those of the subplot, milking durations *(5)*.

Some workers *(3, 12)* have observed that the average milk flow rate declines toward the end of lactation, and Whittleston *(12)* stated that the time to milk does not generally decrease. In this experiment there was a tendency to increase in average rate of flow over the lactation. In contrast to Whittleston and in agreement with Beck *(3)*, a marked decrease in milking time as lactation progressed was evident. Over the lactation, the time to reach peak flow and stripping time decreased but the amount of strippings as a per cent of total yield tended to increase.

*Milking duration.* The twice normal milking duration (Table 3) gave slightly greater amounts of total pounds of milk ($P < 0.10$) and FCM ($P < 0.05$) than did the normal duration, whereas no significant differences were observed for pounds of fat and per cent of fat. Dodd *et al. (7)*, subjecting first calf heifers to a milking duration of either 4 or 8 minutes, found a reduction of fat yield and fat percentage for the cows milked for the shorter duration. A possible explanation for the differences is that Dodd *et al.* used 4 minutes for the shorter duration (which may have been subnormal) in contrast to the cow's own normal milking time used in this experiment. Milking for a twice normal duration significantly reduced ($P < 0.05$) the rate of decrease in total yield of milk, pounds of fat, and FCM, as shown by slower weekly rates for these criteria.

Milking time, time to reach peak flow, and amount of strippings were not significantly altered by the twice normal milking duration (Table 4). However, less time was spent stripping ($P < 0.05$), and faster average rates of flow ($P < 0.05$) were observed in the halves which had the machine left on for the twice normal duration. One possible explanation for the faster milk flow rates was that the prolonged milking over the comparison period of 40 weeks caused a stretching of the teat sphincter muscle, which resulted in a larger

TABLE 3

*Effect of milking duration on milk production of mastitis-free first calf heifers*

| Criterion | Milking duration | | | |
|---|---|---|---|---|
| | Normal | | Twice normal | |
| | Standardizing period | Comparison period | Standardizing period | Comparison period |
| *Lb. of milk* | | | | |
| Av. | 17.8 ±1.2 | 13.3 ±0.7 | 18.1 ±1.2 | 14.5 ±1.1 |
| Weekly rate of change** *(lb/wk)* | | −0.1796 ±0.0272 | | −0.1514 ±0.0250 |
| *Per cent of fat* | | | | |
| Av. | 3.8 ±0.17 | 3.9 ±0.21 | 3.9 ±0.16 | 3.9 ±0.21 |
| Weekly rate of change *(%/wk)* | | −0.0152 ±0.0368 | | −0.0141 ±0.0360 |
| *Lb. of fat* | | | | |
| Av. | 0.689 ±0.055 | 0.504 ±0.029 | 0.708 ±0.056 | 0.548 ±0.038 |
| Weekly rate of change*** *(lb/wk)* | | −0.0050 ±0.1034 | | −0.0040 ±0.0998 |
| *Lb. FCM* | | | | |
| Av.** | 17.4 ±1.2 | 12.8 ±0.6 | 17.8 ±1.3 | 14.0 ±0.9 |
| Weekly rate of change*** *(lb/wk)* | | −0.1402 ±0.0261 | | −0.1222 ±0.0247 |

* $P < 0.10$ ** $P < 0.05$ *** $P < 0.01$

opening and a greater flow of milk. Also, the slightly greater amount of milk obtained from the twice normal halves could have contributed to a slightly higher positive intramammary pressure at each milking. The decrease in stripping time for the twice normal duration apparently was due to the extra amount of milk obtained between the end of the normal milking time and the beginning of machine stripping. Since the amount of strippings for the twice normal halves included the amount of milk obtained between the end of the normal and the end of the twice normal time, the increase in the strippings expressed as a percentage of total yield was expected, whereas the amount of milk obtained during the timing of machine stripping actually decreased.

## SUMMARY

Twelve mastitis-free first calf heifers, nine Holsteins and three Jerseys, after a 4-week standardizing period, were randomly assigned to be milked for 40 weeks at a vacuum level of 10, 13, or 17 in. of mercury. Halves of udders were assigned to a milking duration of either normal or twice normal.

Yields of total pounds of milk, FCM, and fat, and per cent of fat were unaffected by milking at different vacuum levels. Cows milked at higher vacuums tended to be more persistent. Milking time decreased significantly with increasing vacuum and rate of flow increased, but the amount of strippings expressed as

TABLE 4

*Effect of milking duration on milking time, rate of flow, time to reach peak flow, stripping time and amount of stripping of mastitis-free first calf heifers*

| | Milking duration | | | |
|---|---|---|---|---|
| | Normal | | Twice normal | |
| Criterion | Standardizing period | Comparison period | Standardizing period | Comparison period |
| Milking time Av. *(sec.)* | 387 ±140 | 406 ±100 | 534 ±26 | 387 ±34 |
| Weekly rate of change *(sec/wk)* | | −5.477 ±0.764 | | −4.545 ±0.578 |
| Rate of flow Av. *(lb/15 sec.)*** | 0.56 ±0.07 | 0.60 ±0.07 | 0.62 ±0.07 | 0.70 ±0.08 |
| Weekly rate of change *(lb/15 sec/wk)* | | +0.0011 ±0.0008 | | +0.0024 ±0.0012 |
| Time to reach peak flow Av. *(sec.)* | 99.2 ±5.0 | 70.9 ±4.6 | 104.2 ±11.1 | 69.5 ±4.7 |
| Weekly rate of change *(sec/wk)* | | −3.0633 ±0.7908 | | −3.6671 ±0.7820 |
| Stripping time Av. *(sec.)*** | 216 ±42 | 100 ±22 | 204 ±42 | 52 ±6 |
| Weekly rate of change *(sec/wk)* | | −1.546 ±0.347 | | −0.719 ±0.191 |
| Amount of stripping Av. *(% total yield)* | 9.0 ±1.8 | 12.0 ±2.0 | 10.1 ±3.5 | 13.7 ±2.0 |
| Weekly rate of change *(% of total yield/wk)* | | +0.0777 ±0.0751 | | +0.0332 ±0.0507 |

** $P < 0.05$

percentage of total yield tended to be less for the 13 in. group. Stripping time and time to reach peak flow did not seem to be directly related to vacuum levels.

Halves milked for the twice normal time gave slightly greater amounts of milk and significantly more FCM, whereas pounds of fat and per cent of fat were unaffected. The halves milked for the longer duration had significantly slower rates of decrease for total milk yield, pounds of fat, and FCM. Although no differences in the milking time, time to reach peak flow, and amount of strippings were observed, significantly less time was spent stripping, and faster average rates of flow were noted, for the halves milked for twice the normal time.

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# THE UTILIZATION OF MOLASSES AND UREA IN THE RATIONS OF GROWING DAIRY CATTLE

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Molasses has been used as a livestock feed for at least 60 years, and perhaps longer, in the United States. The proportion used for livestock feeding varies because of wide fluctuations in the cost. Often the cost is so high that only small amounts are included in rations of farm livestock. At other times the price is so low that it is the cheapest available source of carbohydrate. Only limited experimental results are available to indicate the value of molasses when it is fed in large amounts.

Early studies concerning the use of molasses are controversial. Georgeson *et al. (10)* claimed that molasses had little value for fattening beef cattle, whereas Craig and Marshall *(9)* obtained an increased rate of gain and observed no ill effects when fattening beef cattle consumed 1 gal. of molasses daily. Grimes *(11)* found that molasses increased the rate of gain of steers fed Johnson grass and cottonseed meal. Blizzard and Taylor *(2)* successfully replaced one-half to three-fourths of the corn for fattening steers with molasses, although slightly more feed was required per unit gain.

It has been found that lactating dairy cattle use molasses effectively when it is fed at 10 to 25% of the concentrate mixture *(5, 13)*. Mather and Bender *(16)* have shown that milk production decreased when equal amounts of TDN from molasses replaced corn. Calloway *(8)* fed 2 lb. of molasses daily to 4- to 6-month-old dairy heifers without ill effects, and Mather and Bender found that molasses fed ad lib. (6 to 20 lb. daily) satisfactorily replaced 4 lb. of a concentrate mixture for growing dairy heifers.

Molasses has been reported in different experiments to depress the digestibility of feed *(14)*, increase the digestibility of hay and mixed feeds *(25)*, and decrease the digestibility of protein *(6, 7, 27, 29)* and ether extract *(6, 7)*.

Since urea is soluble in molasses, combinations of urea and molasses may be made for any desired protein equivalent. Mills *et al. (19)* observed that starch greatly increased the utilization of urea by ruminants. In subsequent work Mills and associates *(20)* found that molasses was not adequate to support maximum protein synthesis. When a small quantity of corn was added to a molasses-urea ration, adequate growth was obtained. At Oklahoma, Bell *et al. (1)* fed various sources of carbohydrates with urea and found that the cereal grains promoted greater nitrogen retention than did molasses. Tillman *et al. (28)* fed varying levels of molasses with corn and/or cottonseed meal to fattening steers. In some of these rations urea was substituted for part or all of the cottonseed meal.

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No significant differences in rate of gain existed between the different treatments. In these studies corn or corn and cottonseed meal constituted at least 60% of the concentrate mixture.

The purposes of this research were: *(a)* to study the utilization of molasses at high levels of supplementation and *(b)* to study more adequately the utilization of urea with molasses as the only carbohydrate supplement when fed with low quality hay to growing dairy cattle.

## EXPERIMENTAL PROCEDURES

Growth and feed utilization studies were conducted in two separate experiments using 80 purebred dairy heifers (predominantly Holstein but with limited numbers of Jersey, Guernsey, and Brown Swiss) from December 1950 to April 1952. In addition, nitrogen balance and digestibility studies were conducted with eight Holstein bull calves using two replicates of a 4 × 4 Latin square design. In these experiments mixed hay was supplemented, with some modifications, as follows: Ration 1, cane molasses, urea (Dupont's 262); Ration 2, corn, soybean oil meal; Ration 3, cane molasses, soybean oil meal; Ration 4, cane molasses, corn, urea.

Except for one group during the first experiment the amount of roughage offered each experimental group of animals was constant. It was poor quality,

TABLE 1

*Average composition of feeds*

| Feed | Dry matter | Composition of dry matter | | | | |
|---|---|---|---|---|---|---|
| | | Crude protein | Ether extract | Crude fiber | Ash | Nitrogen free extract |
| | (%) | (%) | (%) | (%) | (%) | (%) |
| Mixed hay [a] | 89.80 | 6.00 | 2.11 | 35.83 | 4.13 | 51.94 |
| Legume hay [b] | 89.34 | 12.95 | 2.19 | 31.70 | 7.32 | 45.84 |
| Corn meal | 88.26 | 9.98 | 3.31 | 2.40 | 1.48 | 83.17 |
| Soybean oil meal | 90.44 | 51.62 | 1.21 (4.08) [c] | 7.00 | 6.49 | 32.85 |
| Urea (Dupont's 262) | 98.23 | 274.40 | —— | —— | 3.01 | —— |
| Molasses, cane | 68.48 | 5.36 | —— | —— | 10.61 | 84.03 |

[a] Expt. I., U.S. No. 3 timothy, heavy grass mixed hay, 0-10% legumes.
Expt. II & III., U.S. No. 2 mixed hay, predominantly timothy, 5-20% legumes.

[b] Expt. I., second trial. U.S. sample grade mixed hay, 19% foreign matter, 64 to 78% legumes.

[c] Expt. III., expeller extracted soybean meal used; solvent extracted soybean oil meal was used in the other experiments.

mixed hay, predominantly timothy. The animals had free access to dicalcium phosphate, salt, and water at all times. The average composition of the feeds is given in Table 1.

The data obtained from these experiments were tested statistically by the methods outlined by Snedecor *(26)*. Differences were considered to be significant and highly significant at the 5 and 1% probability levels, respectively.

## EXPERIMENTS I AND II (1950-52)

*Procedure.* Rations 1, 2, and 3 were fed to three groups of heifers during the winter of 1950-51. These animals were nearly equal in weight, age, and breed. An equal quantity of hay was offered once daily to each group but in amounts greater than they would consume. Prior to the next feeding, the residual hay was weighed and the amounts recorded. The concentrates were supplied to contain equal quantities of digestible protein and total digestible nutrients (TDN) as calculated from Morrison's tables *(22)*. Heifers in a fourth group were fed hay ad lib., 0.19 lb. urea, and 0.4 lb. of molasses for each pound of hay consumed, based on the previous day's consumption. The corn and soybean oil meal were fed in different mangers from the hay and molasses, and the molasses was spread over the hay at each feeding. These rations were fed for a 10-week period. During a subsequent 9-week period the following changes were made: Ration 4 was fed to the group previously receiving Ration 1 and the amounts of concentrates were increased for the other two groups. A mixed hay of high quality, 64 to 78% legumes, was substituted for the roughage previously used for Group IV.

During the second year the procedure paralleled the first with a few modifications. The four basic rations were fed to similar groups of heifers for 12 weeks. At the conclusion of the period the heifers were reallotted at random to each treatment with the restriction that at least two and no more than three animals were present in each group that had received the same previous treatment. The experiment was continued for an additional 12 weeks. The rations contained equal quantities of crude protein and calculated TDN, but

TABLE 2

*Effect of urea and molasses on growth and feed utilization of dairy heifers. Experiment I (1950-51)*

| Items compared | Period I (10 wk.) | | | | Period II (9 wk.) | | | |
|---|---|---|---|---|---|---|---|---|
| | Group [a] 1 | Group 2 | Group 3 | Group 4 | Group 1 | Group 2 | Group 3 | Group 4 |
| **Av. wt./heifer *(lb.)*** | | | | | | | | |
| Initial wt. | 788.8 | 775.0 | 774.0 | 769.4 | 798.0 | 829.0 | 825.5 | 802.0 |
| Final wt. | 798.0 | 829.0 | 825.5 | 802.0 | 868.0 | 887.0 | 879.0 | 895.0 |
| Daily gain | 0.13 | 0.77 [b] | 0.73 | 0.47 | 1.11 | 0.92 [b] | 0.85 | 1.48 |
| **Av. feed consumed daily *(lb.)*** | | | | | | | | |
| Hay | 17.1 | 14.7 | 17.3 | 16.2 | 16.8 | 14.4 | 16.5 | 19.5 |
| Molasses | 7.7 | —— | 5.6 | 6.7 | 8.5 | —— | 8.5 | 7.8 |
| Corn | —— | 4.0 | —— | —— | 1.2 | 5.0 | —— | —— |
| Soybean oil meal | —— | 0.6 | 1.2 | —— | —— | 0.6 | 1.2 | —— |
| Urea (262) | 0.19 | —— | —— | 0.19 | 0.19 | —— | —— | 0.19 |
| **Feed required/cwt. gain *(lb.)*** | | | | | | | | |
| Hay | 13,154 | 1,909 | 2,370 | 2,219 | 1,514 | 1,565 | 1,941 | 1,318 |
| Molasses | 5,923 | —— | 767 | 908 | 766 | —— | 1,000 | 527 |
| Corn | —— | 539 | —— | —— | 108 | 544 | —— | —— |
| Soybean oil meal | —— | 78 | 164 | —— | —— | 65 | 141 | —— |
| Urea (262) | 146 | —— | —— | 26 | 17 | —— | —— | 13 |

[a] Ten heifers per group.

[b] L.S.D. between the control (Group 2) and any of the other groups is 0.30 and 0.39 lb. daily gain for Periods 1 and 2, respectively, at P 0.05.

the amounts were greater during the second period. The amount of corn in Ration 4 was equal to the amount of soybean oil meal in Ration 3, in both periods.

*Results and discussion.* The results of the first growth study are given in Table 2. The late cut hay used during the experiment was extremely low in feeding value, and the amount of supplementation during Period I was not adequate to produce satisfactory gains in any of the groups of heifers. The daily gains were more satisfactory during the second period and approached the normal value of 1.1 to 1.2 lb. daily as reported by Loosli *et al. (15)*.

The rations containing urea and molasses (Groups 1 and 4, Period I) were not as adequate for growth as those containing soybean oil meal, although the rate of gain was increased when the heifers had more opportunity to select the roughage that they consumed (Group 4, Period I). When 1.2 lb. of corn was added to the ration of each heifer of Group I, the rate of gain was increased from 0.13 lb. daily during the first period to 1.11 lb. per day in the second. This indicates that a small amount of corn increased the efficiency of urea and/or molasses utilization. When good quality roughage was fed with molasses and urea, adequate growth was obtained (Group 4, Period II).

Since a small quantity of corn supplemented a urea-molasses ration so effectively during the first experiment, and since Mills *et al. (20)* obtained similar results, this treatment was included in the next experiment. When corn was fed with molasses and urea throughout the experiment, the response obtained was only slightly greater than without corn (Table 3).

It has been observed elsewhere *(3, 23, 24)* that animals retarded in growth responded more rapidly when given adequate rations than did the control

TABLE 3

*Effect of urea and molasses on growth and feed utilization of dairy heifers. Experiment II (1950-52)*

| Items compared | Period I (12 wk.) | | | | Period II (12 wk.) | | | |
|---|---|---|---|---|---|---|---|---|
| | Group [a] 1 | Group 2 | Group 3 | Group 4 | Group 1 | Group 2 | Group 3 | Group 4 |
| Av. wt./heifer *(lb.)* | | | | | | | | |
| Initial wt. | 801.0 | 801.0 | 810.0 | 806.0 | 868.0 | 865.0 | 862.5 | 867.5 |
| Final wt. | 847.5 | 875.0 | 866.5 | 854.5 | 930.0 | 958.5 | 954.5 | 931.5 |
| Daily gain | 0.55 | 0.88 [b] | 0.67 | 0.58 | 0.74 | 1.11 [b] | 1.10 | 0.76 |
| Av. feed consumed daily *(lb.)* | | | | | | | | |
| Hay | 15.50 | 13.90 | 16.50 | 17.10 | 16.70 | 17.20 | 16.90 | 17.90 |
| Molasses | 7.40 | —— | 6.00 | 6.00 | 8.90 | —— | 7.20 | 7.20 |
| Corn | —— | 4.25 | —— | 1.00 | —— | 5.25 | —— | 1.20 |
| Soybean oil meal | —— | 0.75 | 1.00 | —— | —— | 0.75 | 1.20 | —— |
| Urea (262) | 0.18 | —— | —— | 0.16 | 0.18 | —— | —— | 0.17 |
| Feed required/cwt. gain *(lb.)* | | | | | | | | |
| Hay | 2,818 | 1,580 | 2,463 | 2,948 | 2,257 | 1,550 | 1,536 | 2,355 |
| Molasses | 1,345 | —— | 896 | 1,034 | 1,203 | —— | 655 | 947 |
| Corn | —— | 483 | —— | 178 | —— | 473 | —— | 158 |
| Soybean oil meal | —— | 85 | 149 | —— | —— | 68 | 109 | —— |
| Urea (262) | 33 | —— | —— | 28 | 24 | —— | —— | 22 |

[a] Ten heifers per group.

[b] Daily gains between the control (Group 2) and Groups 1 and 4 were significantly different.

animals. This is probably the effect observed earlier in this study and also by Mills *et al.* In this experiment, the animals fed molasses and soybean oil meal also gained less rapidly than the controls (Group II), but not significantly less.

### EXPERIMENT III (1951-52)

*Procedure.* Since rations that were calculated to be equal produced different growth responses, digestion and nitrogen balance studies were inaugurated with eight Holstein bull calves in two replicates of a 4 × 4 Latin square design. Each period was 8 weeks long. Fecal and urinary collections were made during the last 7 to 10 days of each period. The rations contained equal quantities of crude protein and calculated TDN at all times and were increased as the animals became larger. Within each replicate the amount of feed offered was limited to the amount consumed by the calf with the least appetite. In all cases a maximum amount of hay was fed as determined by appetite; hence the percentage of hay in the ration increased as the calves grew.

*Results and discussion.* The growth data obtained from the bull calves fed the four basic rations are given in Table 4. These data follow the same trend as the previous experiments with dairy heifers except that the animals fed Ration 3 gained more rapidly in comparison to Ration 1.

In the three growth experiments, corn and soybean oil meal supplemented the hay better than molasses and urea or molasses and soybean oil meal. Since Rations 2 and 3 differed only in the source of carbohydrate, molasses was not as effective as corn for growth when fed on an equal TDN basis, though the difference was not significant. The apparent reason is discussed later.

TABLE 4

*Effect of urea and molasses on growth and feed utilization of bull calves. Experiment III (1951-52)*

| Items compared | Experiment III (8 wk.) | | | |
|---|---|---|---|---|
| | Ration [a] 1 | Ration 2 | Ration 3 | Ration 4 |
| Av. wt./animals *(lb.)* | | | | |
| Initial wt. | 290.0 | 271.2 | 275.9 | 279.1 |
| Final wt. | 314.4 | 343.0 | 336.4 | 323.1 |
| Daily gain | 0.44 | 1.28 [b] | 1.08 | 0.79 |
| Av. feed consumed daily *(lb.)* | | | | |
| Hay | 2.87 | 2.87 | 2.87 | 2.87 |
| Molasses | 5.43 | —— | 4.46 | 4.46 |
| Corn | —— | 3.29 | —— | 1.22 |
| Soybean oil meal | —— | 0.95 | 1.22 | —— |
| Urea | 0.19 | —— | —— | 0.17 |
| Feed required/cwt. gain *(lb.)* | | | | |
| Hay | 652 | 224 | 266 | 363 |
| Molasses | 1,234 | —— | 413 | 564 |
| Corn | —— | 257 | —— | 154 |
| Soybean oil meal | —— | 74 | 113 | —— |
| Urea | 43 | —— | —— | 22 |

[a] Each value in the table is the average for 8 animals.

[b] L.S.D. between the control (Ration 2) and any of the other treatments is 0.23 lb. at P 0.05.

Since Rations 4 and 1 were similar to Ration 3 except for the source of nitrogen, it appeared that the nitrogen in urea was not utilized as efficiently for growth as the nitrogen of soybean oil meal and corn. The growth rate of animals fed molasses and urea was increased, but not a significant amount, when a small quantity of corn was added to the ration. The nitrogen balance data are given in Table 5. These results substantiate the growth data and indicate that the

TABLE 5

*Effect of urea and molasses upon nitrogen metabolism*

| Concentrate supplement | Daily nitrogen | | | | | Dietary nitrogen stored | Absorbed nitrogen stored |
|---|---|---|---|---|---|---|---|
| | Intake | In feces | In urine | Digested | Balance | | |
| | *(g.)* | *(g.)* | *(g.)* | *(g.)* | *(g.)* | *(%)* | *(%)* |
| Molasses, urea | 63.2 | 29.6 | 26.8 | 33.6 | 6.8 | 12.4 | 24.2 |
| Corn, soybean oil meal | 64.3 | 26.9 | 20.2 | 37.4 | 17.2 | 26.3 | 45.8 |
| Molasses, soybean oil meal | 65.1 | 32.6 | 17.6 | 32.5 | 14.9 | 22.0 | 44.9 |
| Molasses, corn, urea | 63.4 | 29.7 | 25.3 | 33.7 | 8.4 | 12.8 | 22.3 |
| L.S.D. at P 0.05 | | | | | 6.3 | 7.8 | 14.7 |
| L.S.D. at P 0.01 | | | | | 8.9 | 11.0 | 21.4 |

observed effects were largely the result of differences in nitrogen utilization. Significantly more nitrogen was stored from the corn-soybean oil meal and molasses-soybean oil meal ration than either of the urea supplemented rations. This would indicate that *(a)* the digestibility of the protein formed from urea was low, *(b)* the protein formed had low biological value, or *(c)* the synthesis of protein from urea occurred at a low level in these rations. Since the digestibility of nitrogen of the urea-containing rations was not lower than the soybean-molasses rations, and since McNaught *(18)* has shown that microbial protein from the rumen has a high biological value, it appears that adequate protein synthesis did not occur. Urea per se or as ammonia may be absorbed from the digestive tract but would have little value for the animal and would be subsequently eliminated in the urine. It may be noted that the urinary nitrogen is greatest with the urea-supplemented rations. The percentage of dietary nitrogen stored and of absorbed nitrogen stored show similar trends. The digestibility data are presented in Table 6.

TABLE 6

*The effect of urea and molasses upon the digestibility of different nutrients*

| Concentrate supplement | Digestion coefficients | | | | | |
|---|---|---|---|---|---|---|
| | Dry matter | Organic matter | Crude protein | Ether extract | Crude fiber | Nitrogen free extract |
| Molasses, urea | 66.3 | 66.3 | 54.8 | 28.1 | 31.6 | 78.2 |
| Corn, soybean oil meal | 69.9 | 69.6 | 59.0 | 75.5 | 47.7 | 79.4 |
| Molasses, soybean oil meal | 66.3 | 66.1 | 50.6 | 61.5 | 38.0 | 77.5 |
| Molasses, corn, urea | 66.4 | 67.3 | 54.6 | 52.0 | 32.4 | 78.2 |
| L.S.D. at P 0.05 | 3.7 | 2.5 | 2.2 | 12.2 | 8.1 | n.s. [a] |
| L.S.D. at P 0.01 | n.s. | n.s. | 3.2 | 17.0 | 11.4 | n.s. |

[a] n.s. = nonsignificant at this probability level.

When molasses replaced corn as an energy supplement, the digestibility of protein was significantly reduced. This was more pronounced with the soybean oil meal rations than with the urea-supplemented rations. Compared to the molasses-soybean oil meal rations, urea appears to have increased the digestibility of the protein. Earlier work *(4)* also has shown this to be true. The depression of digestibility by molasses tends to mask this effect. Since molasses decreased the digestibility of protein, this is probably the reason why the soybean oil meal-molasses ration was not equal to the control (corn-soybean oil meal). If additional protein is supplied, it appears that gains comparable to the corn-soybean rations may be obtained from a molasses-soybean ration even when molasses is supplied at high levels. In spite of the depressed digestibility of the protein of the molasses-soybean oil meal ration, the animals gained faster and stored more nitrogen than those fed urea. This supports the theory that protein is not synthesized at a sufficiently rapid rate from urea to maintain growth or maximum nitrogen balance.

The difference in the digestibility of dry matter and organic matter appears to be influenced only by the carbohydrate source. The rations containing corn were significantly more digestible than the rations containing molasses. Organic matter digestibility gave a less variable index of the over-all digestibility of the ration than did dry matter.

The apparent digestibility of ether extract seems to be influenced very significantly by the addition of molasses to the ration. It also appears to be influenced by the type of protein supplement. Briggs and Heller *(6, 7)* observed this effect earlier and found that the digestibility of the ether extract was depressed when sheep were fed rations containing 10% or more of molasses. They also found that the addition of potassium and calcium salts to normal rations in the ratio found in molasses did not depress the digestibility of ether extract.

There is considerable doubt that molasses affects the digestibility of the ether extract portion of the ration. Instead, the observed depression of digestibility is believed to be a function of the level of ether extract in the ration. In the rations that contained only hay, molasses and urea, the only source of ether extract was the hay, which probably contains 25 to 40% of its ether extract as substances that are not esters of fatty acids *(17)*. These materials are probably poorly digestible. This effect is diluted when concentrates higher in true fat are fed, such as corn and soybean oil meal. As the total amount of ether extract in the ration increased above that supplied by the roughage, its apparent digestibility increased. It also appears that when rations low in ether extract, such as molasses, urea and hay, are fed, the metabolic fat will equal, or nearly equal, the intake of ether extract, and thus a low apparent digestibility will be observed. On a ration high in ether extract, the metabolic fat would remain about constant and the apparent digestibility would be greatly increased, although the true digestibility of the ether extract would remain constant. In this study, the ether extract content of the rations varied directly with digestibility and thus supports the above hypothesis. The amount of mo-

lasses fed to the groups receiving *(a)* urea, molasses and corn and *(b)* urea and molasses, was very nearly the same although the digestibility of ether extract in these rations was greatly different.

Molasses significantly depressed the digestibility of crude fiber. When urea replaced soybean oil meal, the digestibility was depressed even more. Mitchell *et al. (21)* and Hamilton *(12)* obtained similar results when they added glucose to the rations of sheep. These authors postulated that the rumen microorganisms probably utilized glucose in preference to the more insoluble carbohydrates, which resulted in a depression of crude fiber digestibility. The digestibility of nitrogen free extract was not affected by any treatment, and the average digestibility was 76.0%.

## SUMMARY

Growth studies have been conducted with 80 dairy heifers over a 2-year period to determine the value of molasses when fed at high levels of supplementation and to study more adequately the utilization of urea with molasses as the source of carbohydrate supplement when fed with low quality hay to growing dairy animals. Digestion and balance studies were also conducted with eight bull calves in two replicates of a 4 × 4 Latin square design.

All the animals with one exception were fed about as much low-quality mixed hay, predominantly timothy, as they would consume, and this was supplemented as follows: Ration 1, molasses and urea; Ration 2, corn and soybean oil meal; Ration 3, molasses and soybean oil meal; Ration 4, molasses, corn and urea.

In every trial but one, the animals that received the soybean oil meal rations with either corn or molasses gained significantly more than the urea-supplemented animals. Molasses apparently was not an adequate carbohydrate for the utilization of urea by the rumen microflora when fed with little or no starchy carbohydrate. When a small amount of corn was fed with urea and molasses, an increase in daily gain was noted which was not statistically significant. The nitrogen balance data have shown that adequate synthesis of protein from urea did not occur in these rations.

Molasses and soybean oil meal did not produce as rapid gains as did corn and soybean oil meal. This may be attributed to the low digestibility of the protein in the molasses rations which were carefully adjusted to supply adequate, but no surplus, protein for a normal ration. Molasses also depressed the digestibility of dry matter, organic matter, ether extract, and crude fiber.

When good quality legume hay replaced the poor quality timothy hay in a molasses-urea ration, excellent gains were obtained, showing that high levels of molasses can produce satisfactory gains when sufficient or excess protein supplied by the hay is available.

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# STUDIES OF FEEDING ALDRIN TO DAIRY COWS

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Aldrin[1] effectively controls many forage insects and is widely used as a pesticide. Range grasshoppers, for example, can be controlled completely with a spray applied at a dosage of 2 oz. of Aldrin per acre. Information on the excretion of Aldrin in the milk of dairy animals is extremely limited.

Kitselman *et al. (5)* studied the toxicity symptoms and tissue concentrations of Aldrin when fed to sheep, beef cattle, and dairy cattle but did not report on the excretion of Aldrin in milk.

The purpose of this study was to: *(a)* ascertain the concentration of Aldrin in the milk of dairy cows fed hay made from Aldrin-sprayed forage, *(b)* determine the approximate dosage of orally administered Aldrin necessary for detection by chemical analysis in the milk of dairy cows, and *(c)* ascertain the relation of various intake levels of Aldrin to the concentration of this insecticide in milk.

## EXPERIMENTAL PROCEDURE

Two similar plots of alfalfa of approximately 4 acres each were sprayed with Aldrin at the rate of 1.8 and 3.9 oz. per acre on May 17, 1951. The Aldrin was applied with a weed sprayer that delivered about 5 gal. per acre at a pressure of 40 lb. per square inch. The hays were harvested 7 days later.

The spray material used in these experiments was labeled "Equivalent to 60% Aldrin, containing 57% hexachloro hexahydro dimethanonaphthalene, 43% related compounds." The chlorine content of this material was 56.4%. The levels of application of Aldrin to the various plots of forage were calculated on the Aldrin basis.

Preliminary samples of the forage sprayed with 1.8 oz. of Aldrin per acre had insecticide residues of less than 1 p.p.m. This lot of hay was not used for experimental feeding. The hay sprayed with 3.9 oz. of Aldrin per acre was fed to four normal, healthy milking cows as their roughage ration. A grain mixture was fed in amounts dependent upon the level of milk production.

The Aldrin-treated hay was fed for 48 days. The animals were then placed on a control hay containing no insecticide residue and were fed measured amounts of Aldrin in capsules containing 10 g. of the commercial "60% Aldrin equivalent solution" per 100 ml. of soybean oil.

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[1] Trade name for an insecticidal product containing 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4, 5, 8-dimethano-naphthalene.

During the experimental period the animals were weighed on two successive days at 10-day intervals. An aliquot of the milk produced by each animal was taken for two consecutive days at 10-day intervals for Aldrin and butterfat analysis. A sample of the Aldrin-treated hay was taken from each bale fed and composited for each 10-day period.

The butterfat content of the milk was determined by the conventional Babcock method. The Aldrin content of the hay fed was calculated from the organic chloride content (corrected for the organic chloride content of a control sample) determined by the method of Carter and Hubanks *(3)*. The Aldrin concentrations of the milk samples were calculated from the organic chlorine content determined by the method of Carter *(1)*. The results given for the p.p.m. of Aldrin in milk were corrected for the organic chlorine concentrations of control milk determined at the same time. The average organic chlorine content of 18 control milk samples taken throughout the course of the tests was 1.27 ± 0.11 [2] p.p.m. Determinations of known amounts of Aldrin added to control milk (approximately 13 p.p.m.) gave recoveries ranging from 80 to 95%. Milk samples with an apparent Aldrin content below 1.0 p.p.m. were recorded as zero.

## RESULTS AND DISCUSSION

A summary of the results of feeding the hay made from Aldrin-sprayed alfalfa to four cows for 48 days is presented in Table 1. The hay consumed had average Aldrin contents of 6.6 to 7.1 p.p.m. The average daily Aldrin intakes of the animals ranged from 0.10 to 0.15 mg. of Aldrin per kilogram of body weight.

TABLE 1

*Summary of Aldrin-sprayed hay feeding experiment*

| Cow No. | Feeding period | Av. daily hay consumption | Av. Aldrin on hay | Av. daily Aldrin intake | | Av. daily milk yield | Aldrin content of FCM |
|---|---|---|---|---|---|---|---|
| | *(days)* | *(lb.)* | *(p.p.m.)* | *(mg.)* | *(mg/kg)* | *(lb.)* | *(p.p.m.)* |
| N661 | 48 | 10.3 | 7.1 | 33 | 0.10 | 18.9 | 0 |
| N669 | 48 | 15.3 | 6.6 | 46 | 0.15 | 14.4 | 0 |
| N675 | 48 | 13.2 | 6.8 | 41 | 0.15 | 23.1 | 0 |
| N171 | 48 | 22.5 | 6.6 | 67 | 0.14 | 35.4 | 0 |

No Aldrin was detected in the milk of these cows during the 48-day feeding period. No physiological effects on the animals were observed during this period.

The results of feeding various dosages of Aldrin in soybean oil administered by capsule are presented in Table 2. Dosages ranging from 0.1 to 2.2 mg. of Aldrin per kilogram of body weight were fed. The Aldrin intakes were calculated on the basis that the material fed was equivalent to 60% of Aldrin. These dosages were also calculated as the equivalent amount of Aldrin present on the ration consumed (grain plus hay) and ranged from 2.7 to 59.3 p.p.m. of the ration.

[2] Standard error of the mean.

TABLE 2

*The excretion of Aldrin in the milk of cows fed Aldrin in soybean oil*

| Cow No. | Feeding period | Aldrin fed daily | | | Av. daily milk yield | Aldrin in FCM | | |
|---|---|---|---|---|---|---|---|---|
| | *(days)* | *(mg.)* | *(p.p.m.)* | *(mg/kg)* | *(lb.)* | *(p.p.m.)* | *(mg. daily)* | *(% dose)* |
| N171 | 43 | 42 | 2.7 | 0.1 | 32.2 | 0 | 0 | 0 |
| N675 | 43 | 54 | 4.8 | 0.2 | 21.3 | 0 | 0 | 0 |
| N669 | 43 | 84 | 7.9 | 0.3 | 13.0 | 0 | 0 | 0 |
| N661 | 86 | 120 | 14.8 | 0.4 | 18.1 | 0 | 0 | 0 |
| N675 | 43 | 120 | 10.8 | 0.4 | 17.8 | 0 | 0 | 0 |
| N669 | 43 | 180 | 16.8 | 0.6 | 12.3 | 0 | 0 | 0 |
| N171 | 43 | 300 | 18.5 | 0.6 | 28.9 | 0 | 0 | 0 |
| N661 | 44 | 240 | 30.6 | 0.8 | 15.8 | 3.8 | 28 | 12 |
| N669 | 44 | 300 | 28.0 | 1.0 | 13.5 | 4.3 | 32 | 11 |
| N675 | 44 | 420 | 37.7 | 1.5 | 16.7 | 6.4 | 58 | 14 |
| N171 | 29 [a] | 960 | 59.3 | 2.2 | 25.7 | 12.6 | 131 | 14 |

[a] N171 died on 29th day.

No Aldrin was detected in the milk when less than 0.8 mg. per kilogram of body weight or 28 p.p.m. of the diet was fed. When 0.8, 1.0, 1.5, and 2.2 mg. per kilogram of body weight were fed, the average calculated concentrations of Aldrin in the fat-corrected milk were 3.8, 4.3, 6.4, and 12.6 p.p.m., respectively. From 11 to 14% of the Aldrin administered was excreted in the milk when these four dosage levels were fed. If the chlorinated hydrocarbons are excreted into the milk in the same proportions as present in the material administered, the Aldrin concentrations in the milk would be approximately 60% of the calculated values.

Although the animal (N171) receiving 2.2 mg. of Aldrin daily showed symptoms of hyperirritability on May 21, after 27 days of administration, Aldrin feeding was continued. This animal was in heat and bred on May 22 and was very nervous. On May 23 at 10:30 A.M. she was observed lying on her side slightly bloated, with clonic spasms of the legs and tetanic spasms of the abdominal and chest muscles. She went from a semicomatose condition to unconsciousness in about 15 minutes after she was first observed and died a few minutes later. Autopsy showed a slightly discolored, pulpy liver with acute passive congestion. One kidney was slightly enlarged and showed acute congestion. No other gross pathology was observed. A total of 27.8 g. of Aldrin was fed to this animal in the 29 days prior to death. The length of time for the symptoms of toxicity to occur with Cow N171 receiving 2.2 mg. of Aldrin daily per kilogram of body weight checks closely with the results reported by Kitselman *et al. (5)* who observed similar symptoms 29 days after a heifer was fed approximately the same dosage. Kitselman *et al.* also reported the death of a cow receiving 2.0 mg. per kilogram of body weight on the 33rd day of feeding.

Samples of the liver, kidney, muscle, kidney and body fat, and bile were taken for organic chlorine analysis. The calculated Aldrin concentrations found in these tissues are given in Table 3. These figures have not been corrected for the organic chlorine content of control tissue samples, since comparable tissue samples from an untreated animal were not available. Fat and liver samples

from animals on feeds free from chlorinated insecticides have been found to contain 2 p.p.m. or less of organic chlorine *(2)*.

A study of the excretion of Aldrin in the milk of cows after discontinuing its administration was made with three of the animals receiving Aldrin in soybean oil. These data are shown in Table 4. These results indicate either a relatively small tissue storage or rapid removal of stored Aldrin, since none could be

TABLE 3

*Concentrations of Aldrin in selected tissues of Animal N171*

| Tissue | Aldrin |
|---|---|
| | *(p.p.m.)* |
| Kidney and body fat | 109.4 |
| Liver | 13.1 |
| Kidney | 3.4 |
| Muscle | 2.1 |
| Bile | 0.9 |

TABLE 4

*The excretion of Aldrin in cow's milk after cessation of Aldrin feeding*

| Cow No. | Aldrin fed daily | Aldrin in FCM | | | | | |
|---|---|---|---|---|---|---|---|
| | | During feeding period[a] | | 8 days after cessation | | 18 days after cessation | |
| | *(mg.)* | *(p.p.m.)* | *(mg. daily)* | *(p.p.m.)* | *(mg. daily)* | *(p.p.m.)* | *(mg. daily)* |
| N661 | 240 | 3.8 | 28 | 1.8 | 12 | 0 | 0 |
| N669 | 300 | 4.3 | 32 | 2.9 | 21 | 0 | 0 |
| N675 | 420 | 6.4 | 58 | 3.3 | 27 | 0 | 0 |

[a] Av. values during a 44-day feeding period.

detected in the milk, 18 days after cessation of feeding. This indicates a more rapid removal of stored Aldrin than has been reported for the excretion of DDT *(6)* and lindane *(4)* by dairy cows after cessation of insecticide feeding. It is possible that tissue storage of Aldrin is not reflected by its excretion in milk after discontinuing dosage, since Kitselman *et al. (5)* found 0.9 p.p.m. of Aldrin in fat obtained by biopsy of a heifer 90 days after cessation of feeding at the rate of 2.0 mg. per kilogram of body weight. Our results indicate that a greater concentration of Aldrin may be excreted in the butterfat than is stored in the body fat. The butterfat from Cow N171 contained approximately 300 p.p.m. of Aldrin after she had received 960 mg. daily for 23 days, whereas body fat from the same cow after death on the 29th day contained 109 p.p.m.

## SUMMARY

No Aldrin was detected in the milk of cows fed hay made from forage sprayed with 3.9 oz. of Aldrin per acre and harvested 7 days after spraying.

No Aldrin was detected in the milk of cows fed less than 0.8 mg. of Aldrin per kilogram of body weight, or 28 p.p.m. of the diet.

When 0.8, 1.0, 1.5, and 2.2 mg. of Aldrin per kilogram of body weight were

fed, the average concentrations of Aldrin in the fat-corrected milk were 3.8, 4.3, 6.4, and 12.6 p.p.m., respectively. From 11 to 14% of the Aldrin administered was excreted in the milk.

No Aldrin was detected in samples taken 18 days after cessation of Aldrin feeding.

One animal that received 2.2 mg. of Aldrin per kilogram of body weight showed symptoms of toxicity on the 27th day of feeding and died after 29 days of feeding at this level of intake.

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# THE INFLUENCE OF OXYTOCIN-INDUCED UDDER EVACUATION ON MILK AND BUTTERFAT PRODUCTION IN A COMPLETE LACTATION [1]

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The work of Gaines *(6)* and the further elucidation of the let-down mechanism by Ely and Petersen *(3, 4)* and Petersen and Ludwick *(12)* have stimulated much interest in oxytocin, a posterior pituitary gland hormone, which causes the ejection of milk from the mammary gland. The amount of milk obtained by the use of oxytocin following a normal milking is generally related to the level of production *(15)* and still more specifically to the total amount of milk in the udder at the time of milking *(7, 16)*. The residual milk apparently is made up of constituents which normally find their way into subsequent milkings, and following oxytocin treatment the subsequent milking is low by approximately the residual in milk and fat *(1)*. The effect of oxytocin administration at consecutive milkings is still controversial, but most investigators find an increased production during the treatment *(9, 14)*. Shaw *(13)* found no measurable effect.

Trials have not been carried out in which oxytocin has been administered at regular intervals throughout a complete lactation. Further, no critical experiments have ascertained minimum effective levels of oxytocin administration and factors influencing this minimum effective level.

This paper deals specifically with the effect of oxytocin administration throughout a complete lactation, examines in a limited way the lower limits of effective dose level, and coincidentally notes factors affecting response to certain levels.

## EXPERIMENTAL

One set of identical twins, T63 and T64, was used as control and experimental. In this way more conclusive data resulting from experimental procedures can be had than if small groups of heterogeneous cows are used. However, the results of an experiment from one set of identical twins will not be applicable universally to other genotypes. In the first lactation both animals were milked as regular herd animals to ascertain their genetic potentiality in regard to milk production. In the second lactation T63 was again milked and managed as a regular herd animal while T64 was designated as the experimental animal. The only deviation from regular barn procedures to which T64 was subjected was oxytocin treatment. Following regular milkings, oxytocin was administered intravenously to T64 and the residual milk was removed. The schedule of oxytocin injections was as follows: No oxytocin was administered for the first 9 days after freshening; in the next 6 days oxytocin was given only at

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evening milkings; for the remainder of the lactation, oxytocin was administered at each milking. When the normally obtained milk per milking fell below 1 lb., oxytocin was injected prior to the start of milking and all the milk obtained was designated "residual milk." The milk obtained normally was termed "first milk." The amount of oxytocin injected was 3 I.U. per injection for each milking beyond the sixth week. In the period previous to this, dosage levels were systematically reduced from 30 to 1.5 I.U. per injection. The oxytocin used was a commercially prepared and assayed preparation of high activity with very small amounts of vasopressin. Unfortunately, however, the potency of this preparation doubled at some time since it was first assayed. The potency changed from 30 I.U. per milliliter 3 months prior to the start of the trial to 60 I.U. per milliliter during the trial. The unitages reported as used are based upon the prior assay and neglect the change in potency. It is felt that this potency change did not in any way influence the results or their interpretations.

Butterfat percentages were determined weekly on one day A.M. and P.M. composited first and residual milks by conventional methods.

In the third lactations, T63 received the injections of oxytocin while T64 was the control. Only data from the first 10 weeks of the third lactations are included as the lactations are still in progress. T63 received 3 I.U. oxytocin at each milking from the fourth day after freshening.

## RESULTS

In the first lactation T63 milked 58 days in which she produced 183.3 lb. of milk containing 4.68 lb. fat, and T64 milked 53 days and produced 316.5 lb. of milk and 9.35 lb. fat.

In the second lactation T63, the control, produced 1,071.0 lb. of milk and 38.61 lb. fat in 85 days, and the experimental animal, T64, produced 6,054.3 lb. of milk containing 214.7 lb. fat in 252 days. Thus, T64 produced 5.7 times as much milk and 5.6 times as much fat as T63. These relationships are shown in Figure 1.

In Figure 2, there is plotted the amount of milk obtained as first milk and as residual. The milk weights presented are average daily milk weights for

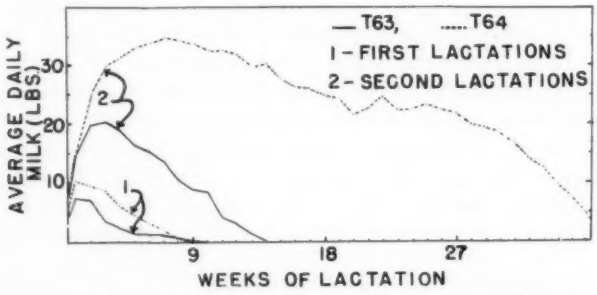


FIG. 1. First and second lactations of T63 and T64, average daily milk weights on a weekly basis.

weekly periods. The butterfat percentages also are recorded in Figure 2. These figures are fat percentages derived from composited A.M. and P.M. milks taken one day each week; the first and residual milks were kept separately.

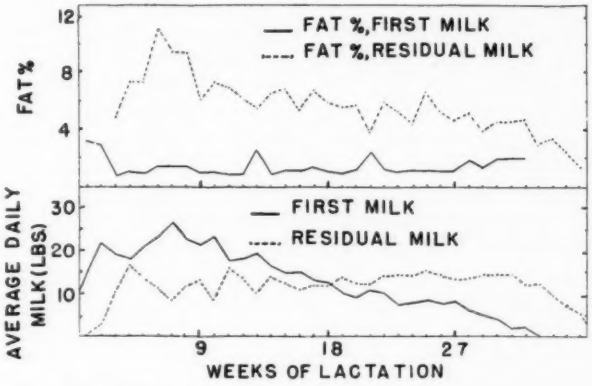


FIG. 2. Second lactation of T64.

Upper section: Butterfat percentages, determined once weekly on A.M. and P.M. composites of first and residual milks.

Lower section: Average daily milk weights on a weekly basis for naturally obtained first milk and oxytocin obtained residual milk.

Of the 6,054.3 lb. of milk produced by T64, 3,058.9 lb. were obtained as first milk and 2,995.4 lb. were obtained as residual. The 214.7 lb. of fat were partitioned 44.05 lb. for first and 170.65 lb. for residual milk. The average butterfat percentage of the first and residual milk was 1.44 and 5.74, respectively. This would indicate that on the average only 50% of the milk and 20% of the fat were available to a normal stimulus under the conditions set forth.

Table 1 presents the production of total milk and butterfat for the first 10 weeks of both the second and third lactations of T63 and T64 for comparisons. It is seen that in the third lactation, production rates are above the second in

TABLE 1

*Production of milk and fat in the first 70 days of the second and third lactations of T63 and T64*

| Cow | Lactation | Treatment | Milk | Butterfat |
|---|---|---|---|---|
| | | | (lb.) | (lb.) |
| T63 | 2 | control | 1,031.4 | 37.74 |
| T64 | 2 | oxytocin | 2,136.1 | 74.31 |
| T64 | 3 | control | 1,524.1 | 49.54 |
| T63 | 3 | oxytocin | 2,953.9 | 96.43 |

both the control and the experimental by a factor of about 1.5. Comparing the experimental with the control over the 10-week period, it is seen that the experimental gave approximately twice as much milk and fat as the control.

## DISCUSSION

The results of the first lactations of T63 and T64 show definitely that they are not greatly different when considering the wide spectrum of production levels within the identical twin herd. The first lactation records of T63 and T64 are by far the lowest among 2-year-olds which have production records that range up to 487 lb. of fat in 13,000 lb. of milk under identical barn practices. The fact that these animals did not produce amounts of milk and fat more nearly alike in the first lactation is probably explained by the slight difference in the environment surrounding their respective freshenings. Neither animal had been handled extensively or "exposed" to milking machine routine until T63 freshened, and since the animals occupied adjacent stalls, it is probably safe to assume that the handling of T63 influenced the temperament of T64. Because T64 freshened 3 months later, the period of adjustment with the one animal milking could very likely explain the difference observed. It was clearly demonstrated by Ely and Petersen *(1)* that fright or excitement could interfere with the let-down response, which in turn would limit production, as shown by Miller and Petersen *(10)*.

There is little doubt that the procedure of removing the residual milk from T64 at each milking for the greater part of her second lactation caused her to out-produce her control by a factor of approximately six times in both milk and fat. The same factors were instrumental in causing the treated cow to out-produce the control in the first 10 weeks of their third lactations.

From Figure 2 it will be seen that the amount of residual milk remained relatively constant until only slight amounts of milk were obtained by natural means. This finding is contrary to that reported by Swanson and Hinton *(15)* and, in terms of their interpretation, would indicate that the active alveolar surface remained relatively constant throughout most of the lactation.

Milk production appears to be limited by end product space, the removal of end products per se, and by secretory activity governed by metabolic processes. In the early part of lactation all factors probably are operative, and in later lactation the second factor appears to be the limiting one. Secretory activity may be limiting at any time. The greater portion of the milk storage space is within the area from which milk is ejected under the let-down stimulus. If the space normally occupied by the residual milk were kept at a minimum by forced evacuation, there would be an increased amount of end product space allowing for an increased amount of new milk to be formed. In this experiment, removal of the milk by the use of oxytocin has been much more effective in raising production than would be expected from milking at more frequent intervals than twice daily *(5)*. This would indicate that the completeness of removal of milk is more important than creating space itself, as would be done by decreasing the interval time between milkings.

The decline in production of T64 in the mid-experimental period appeared to be due to a declining metabolic activity of a relatively static mass of mammary secretory epithelium, if the "effective secretory area" is measured by the amount of residual milk ejected by exogenous oxytocin. The natural let-down stimulus

apparently was able to contract the myoepithelial tissue as a whole only to a certain incomplete degree, thus allowing the alveoli to hold a significant volume of residual milk following the natural ejection. This residual milk was in turn ejected relatively effectively by the administered oxytocin as evidenced by the low-fat first milk, indicating that there was no carry-over of residual to the next milking. It has been shown by others *(6, 7)* that the fat per cent in consecutively drawn portions of a regular milking increased from the first to the last drawn portions. The fact that there was an increasing per cent of the milk obtained as residual throughout lactation would satisfactorily explain the decline in butterfat per cent of the residual milk following the sixth week of lactation as a dilution effect and not due to an increasing ineffectiveness of oxytocin in expressing the residual milk.

The sharp decline in milk production which caused the lactation of T64 to come to an abrupt halt appeared to be due primarily to an incomplete evacuation of milk. The first milk became richer in fat while decreasing in amount and as a per cent of the total milk indicating a carry-over of fat-rich residual milk from the prior milking. Although the residual milk decreased in amount, it increased as a per cent of the total. The butterfat per cent of the residual milk became lower in this period not only because it was an increased portion of the whole (dilution effect) but because it was being incompletely evacuated.

The ineffectiveness of the administered oxytocin may have resulted because the myoepithelium of the alveoli had developed a refractoriness. It is also possible that oxytocin may not have reached the myoepithelium of the udder tissue because of an increased inactivation within the blood or because of a blocking of the blood supply carrying oxytocin to the mammary gland.

It appears from these observations that this particular genotype, represented by this set of twins, is unable to react fully to its endogenous oxytocin early in lactation and that finally in the later stages of lactation even exogenous oxytocin became ineffective.

Generally the fat percentage of the first milk was low, as would be expected following a fairly complete removal of the residual milk at the previous milking. There were two periods in mid-lactation in which the pattern of low-fat first milk deviated slightly. These two periods coincided with somewhat lower fat percentages in the residual milk, indicating that on those particular days the response to oxytocin may have been subnormal. It should again be pointed out that although daily milk weights were averaged weekly and thus variations were minimized, fat percentages were determined for one-day composites and could as a result magnify variations between periods.

In regard to the amounts of oxytocin utilized and the responsiveness to these amounts, it can be said that apparently amounts below ten units are quite effective. The amount per injection was decreased from 30 to 1.5 I.U. through the first 6 weeks. It first appeared that the smaller amount of residual milk reflected a lessened response to lower dosages of oxytocin. This is not borne out, because the residual milk in this period was very high in fat, whereas the first milk was low, which indicated a desirable milk ejection. Levels lower than 1.5 units

of oxytocin per injection were not examined. The minimum effective level of 1.5 I.U. was doubled for the remaining part of the lactation to insure effective ejection.

Even when three units of oxytocin per injection were used, there was no response on certain occasions. In the estrous period at which the cow was bred, she did not respond to two injections. At another period in which the personnel doing the injecting was changed, there was excitement and unresponsiveness to repeated dosages. Occasionally, when the cow moved her neck and the injection missed the jugular vein there was no response. It was the practice to ascertain the proper position of the needle by withdrawing blood into the syringe both before and after injection of the oxytocin. One could easily distinguish the few occasions when a second injection was needed for this reason, contrasted to periods of refractoriness, in which a second injection was also ineffective.

An interesting observation of unknown significance was that T64 developed a true pitting edema over the surface of the udder, which closely resembled that seen at freshening. The swelling coincident to freshening had receded in a normal manner. After the first week of treatment, marked edema was again noticed for the next 2 months and then it gradually receded over the next month. Whether or not this phenomenon is related to water balance is not ascertainable from these data. There is evidence, however, that in the dog, the woman, and the cow, the natural milk let-down phenomenon is accompanied by anti-diuresis of a temporary nature *(8, 11)*. Edema has not been reported to be implicated with milk-ejection processes.

## SUMMARY

One set of identical twin cows was observed through two complete lactations and the first 10 weeks of their third lactation. In the first lactation, milk production was extremely low for both mates under like conditions. In the second lactation, one mate was used as a control while oxytocin was administered to the other in amounts varying from 30 to 1.5 I.U. per injection immediately following each regular milking, starting shortly after freshening. The residual milk was then removed. In the third lactation the mates were reversed as control and experimental subjects. In the second lactation, the experimental animal produced 5.7 times as much milk and 5.6 times as much butterfat as her mate. In the third lactation, the experimental animal again out-produced the control in the first 10 weeks in approximately the same manner as in the second lactation.

Oxytocin appeared to be quite effective in amounts down to 1.5 I.U. per injection based on the early assay, although fright or excitement raised the threshold level to more than four times this amount, as noted by lacks of response to repeated injections on certain occasions.

The exact mechanism whereby this increase in milk production was brought about is unknown. Not only did the complete ejection of milk from the mammary

gland allow for the maximum space for accumulation of milk before secretory pressures were balanced by intra-alveolar pressures; it appeared to be stimulatory beyond the space factor alone.

ACKNOWLEDGMENT

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# FAT SEPARATION IN EVAPORATED MILK
## II. AGE-THINNING OF CONCENTRATED, STERILIZED MILK[1]

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During the process of sterilization of evaporated milk there is a gradual increase in the viscosity, or the body of the product. However, there is a reduction in the viscosity especially during the early phase of storage. This loss in viscosity, referred to as age-thinning, continues for a number of months.

The extent of age-thinning is of considerable importance, because a low viscosity allows more rapid fat separation and a general detraction from the salability of the product. Mojonnier and Troy *(4)* and Deysher, Webb, and Holm *(1)* have shown that age-thinning proceeds most rapidly immediately after sterilization. The latter group concluded that the rate of age-thinning decreases until the milk reaches a basic viscosity, which means the milk has ceased to undergo rapid age-thinning, or that age-thickening has set in. Age-thickening is an increase in viscosity that takes place on extended storage. Webb, Deysher, and Hufnagel *(6)* reached the following conclusion: "The viscosity of all evaporated milks dropped to a basic level during storage. The relationship between the time required for a milk to thin to such a level (to a basic viscosity) and the storage temperature was logarithmic with respect to time." It is not clear whether the viscosities of all evaporated milks decline to the same level, or that all evaporated milks exhibit this decline in viscosity, each to its own characteristic level. More recently Webb, Deysher, and Potter *(7)* showed that each sample of evaporated milk will tend to reach its own minimum viscosity before age-thickening commences. In addition, they showed that the temperature of storage is directly related to the logarithm of the reciprocal of the time required for a sample to lose a definite viscosity value.

The loss in viscosity is a critical factor in the consideration of fat separation. Therefore, to determine the effectiveness of viscosity in retarding fat separation, it is necessary to know the average or representative viscosity value that is active throughout the storage period. The following work was undertaken primarily to develop a technique whereby this value could be determined.

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[3] Deceased.

## EXPERIMENTAL

Evaporated milk was prepared according to a normal commercial process *(3)*. One can was used for each viscosity measurement at 100° F. with a modified Gardner mobilometer *(2)*. The remainder of the cans were stored under quiescent conditions at 100° F., except for a single gentle inversion each day to prevent fat separation.

The greatest loss in viscosity occurred during the first few days with a progressively smaller loss for each succeeding day. When these data were plotted with the viscosity as the ordinate and the logarithm of the time of storage as the abscissa, the points formed a straight line (Figure 1). This relationship makes possible the calculation of the average viscosity during the early phases of quiescent storage.

The temporary viscosity formed during sterilization can be dissipated by simple agitation. For example, cans of evaporated milk were placed on a reciprocating agitator for one hour and the viscosity was reduced to approximately one-half the original value. The effectiveness of agitation in the cans apparently is limited by the foaming or whipping of the air of the headspace into the product. Thus, the effectiveness of the concussion is reduced.

An Osterizer can be used to obtain violent agitation and avoid whipping air into the product. This device consists of propeller blades that are constructed in an assembly for closing the container on which it is to be used. Since the assembly is designed to fit a standard glass jar, it is possible to utilize a container that can be filled completely with liquid.

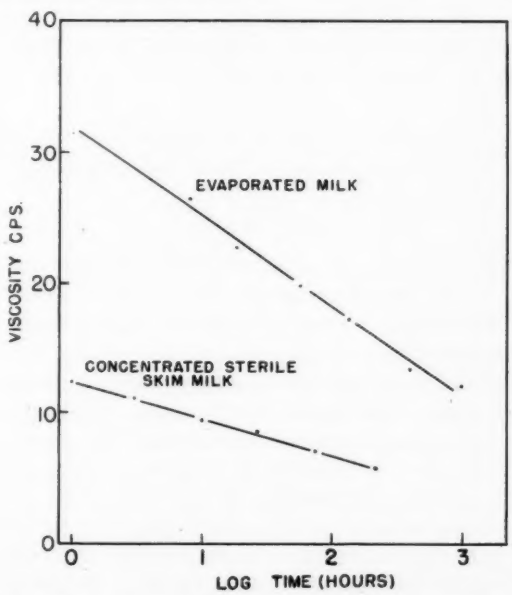


FIG. 1. The pattern of age-thinning during quiescent storage at 100° F.

When samples of sterilized evaporated milk were agitated for 30 seconds in the Osterizer, the viscosity was reduced to near that of the original unsterilized milk. The viscosity, after treatment with the Osterizer, was slightly higher for samples that had been given a longer sterilization treatment. For example, when the time of sterilization was 14, 15, and 20 minutes, the viscosity was 7.2, 7.4, and 7.8 cps., respectively. The viscosity of the concentrated milk prior to sterilization was 5.2 cps. The values are what might be expected as the basic viscosity reached through age-thinning.

Since the viscosity formed during sterilization could be reduced quickly by mechanical agitation and since any consideration of fat separation in evaporated milk during storage would include a consideration of the state of dispersion of the butterfat, it seemed logical to determine the effect of butterfat on the pattern of age-thinning.

Mixed skimmilk from the University creamery was forewarmed at 150° F. for 30 minutes and then condensed to slightly less than half the original volume. A Mojonnier test for total solids was performed on the concentrated product, and sufficient distilled water was added so that the resulting product contained 19.7% total solids—the percentage of solids-not-fat in the aqueous phase of evaporated milk. The remainder of the procedure was the same as for the concentrated whole milk.

From a representative set of the data given in Figure 1, it is apparent that concentrated, sterilized skimmilk showed the same pattern of age-thinning as evaporated milk. That is, there was an inverse relation between the viscosity and the logarithm of the storage time. One may conclude, therefore, that the pattern of age-thinning is completely independent of the butterfat. Thus, the proteins undoubtedly constitute the structures that account for the apparent viscosity.

It may be of interest to note that Shahani and Sommer *(5)* found an increase in the nonprotein nitrogen of evaporated milk during storage.

## CALCULATIONS

As was pointed out in the previous section, the viscosity during storage was inversely related to the logarithm of the storage time. Thus, a straight line was formed and the average viscosity was the average height of the line; this average height was calculated.

The method of calculation can best be exemplified by a sample problem: Assume the viscosity after 1 hour was 30 cps. and after 7 days it was 20 cps. The general equation for a straight line passing through the above points would be $V = m \log t + b$. Where $V$ is viscosity, $m$ is the slope of the curve, $t$ is time of storage, and $b$ is a constant determining the intercept of the line. Substituting the specific values into the above equation, it becomes $V = -4.494 \log t + 30$.

The average height *(h)* is obtained by determining the area *(A)* under the curve and dividing the time *(t)* involved in the test. The area between 0 time and 168 hours is determined as follows:

$$
\begin{aligned}
A &= \int_{t_1}^{t_2} V dt \\
&= \int (-4.494 \log t + 30)\, dt \\
&= -4.494 \int \log t dt + 30t \\
&= -4.494\ (t \log t - 0.4343t) + 30t \\
&= -4.494\ t \log t + 31.95t
\end{aligned}
$$

Substituting into the above equation for a time *(t)* of 1 hour the equation becomes:

$$
\begin{aligned}
A_1 &= -4.494 \log 1 + 31.95 \\
&= 31.95
\end{aligned}
$$

To determine the area to time 168, the equation becomes:

$$
\begin{aligned}
A_2 &= (-4.494 \times 168 \log 168) + (31.95 \times 168) \\
&= 3{,}687.5
\end{aligned}
$$

The area between time 168 and time 1 is $A_2 - A_1$ or 3,687.5.

The average height *(h)* is:

$$h = \frac{A_2 - A_1}{t_2 - t_1} = \frac{3{,}687.5 - 31.95}{168 - 1} = 21.9$$

Thus, the average height of the line is 21.9, which is the average viscosity of the sample chosen in the above example.

## DISCUSSION

The pattern of age-thinning of evaporated milk can be subjected completely to definitive mathematical relationships. The rate of age-thinning (the slope of the age-thinning curve) is inversely related to the storage temperature, the intercept of the line being directly related to the initial viscosity. In addition, the viscosity of a sample of evaporated milk is inversely related to the logarithm of the storage time, the slope being determined by the initial viscosity and the storage temperature. For example, during the first 3 days the viscosity loss will be the same as for the subsequent 27 days.

The above generalizations are based on age-thinning under quiescent storage conditions. Intermittent agitation would disrupt the original pattern, but only the rate of age-thinning would be altered. The fundamental relationship should hold for any given period of quiescent storage.

The rate of age-thinning or the slope of the curve as given in Figure 1 and the final viscosity are the most important considerations. These values have practical significance in so far as the slope is directly related to storage temperature, and the final value, or the value obtained during extended storage periods, indicates the viscosity that will be operative in preventing fat separation during delayed marketing conditions.

The above considerations have theoretical significance in that a method exists for studying the mechanism of the age-thinning phenomenon. Furthermore, the above relationship permits calculation of the average viscosity for consideration in the problem of fat separation.

## SUMMARY

Data are presented to characterize further the phenomenon of age-thinning of evaporated milk. The loss of viscosity is inversely related to the logarithm of the storage time, and the slope of the curve for age-thinning is directly related to the storage temperature. These relationships can be expressed in mathematical terms. A method is presented for the utilization of the above relationships in the calculation of the average viscosity during the early stage of quiescent storage. In addition, a method is described whereby it is possible to dissipate quickly the temporary viscosity formed during sterilization.

## ACKNOWLEDGMENT

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# EFFECT OF FORM OF ALFALFA WHEN FED AS THE SOLE SOURCE OF ROUGHAGE TO GUERNSEY COWS ON THE CAROTENOID AND VITAMIN A CONTENT OF MILK [1]

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In an earlier experiment conducted at this station *(17)*, a decrease in milk fat concentration was observed when either the ground or pelleted forms of artificially-dried alfalfa were fed as the sole source of roughage. Previous workers have reported a decrease in fat percentage *(3, 10, 13, 17, 18, 19, 20, 22, 24)* and an alteration in milk fat composition *(3, 6, 22)* apparently due to a change in the amount or form of roughage fed. In the second experiment of this series *(17)*, the effect of artificially-dried and chopped, artificially-dried and pelleted, and field-cured and field-baled forms of alfalfa on the carotenoid and vitamin A content of milk was investigated.

## EXPERIMENTAL

*Animals and rations.* Eighteen Guernsey cows from the University of Connecticut dairy herd, during the period January-August 1951 were divided into six groups each of three relatively homogenous cows based, in so far as possible, on age, stage of lactation, body weight, and milk production. The three cows within a group were each fed separately the three forms of alfalfa in a double change-over design *(7)*. Each of the three forms of alfalfa, namely, artificially-dried and chopped, artificially-dried and pelleted, and field-cured and field-baled, was fed for a 40-day period. The data collected for the initial 10 days of each feeding period were excluded from the calculated results. Sufficient amounts of these hays were fed to insure a weigh-back of 5 to 10% of the amount fed daily. Grain was fed on the basis of milk production. Detailed descriptions of the various feeds fed and methods of feeding appeared

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[1] This study was made in part with funds provided by the Chas. M. Cox Co., Boston, Mass., and by the Research and Marketing Act of 1946 through a contract between the Storrs Agricultural Experiment Station and the Bureau of Dairy Industry. These data are in part from a thesis submitted to the Graduate School of the University of Connecticut by the senior author in partial fulfillment of the requirements for the M.S. degree.

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in a previous publication *(17)*, which reported the relative milk production resulting from feeding the three forms of alfalfa.

*Observations and analyses.* Both roughage and grains fed and refused were weighed to the nearest 0.1 lb. Composite samples of the three forms of alfalfa and the grain fed, and of the field-cured and field-baled refused, were collected for consecutive 30-day periods during the time of the experiment. Carotenoid content was determined by the method of Moore and Ely *(14)* as modified by Nelson *et al. (16)*. The average carotenoid concentration in milligrams per pound with standard errors was for the artificially-dried and chopped, 31.06 ± 2.48 as fed; for the artificially-dried and pelleted, 28.80 ± 3.22 as fed; for the field-cured and field-baled, 3.60 ± 0.40, and 2.50 ± 0.64 as fed and refused, respectively; and for the grain, 0.10 ± 0.00 as fed.

The milk was weighed to the nearest 0.1 lb., and aliquot samples from the A.M. and P.M. milkings were obtained from each cow on the 20th, 30th, and 40th days of each experimental period. A portion of each aliquot sample was analyzed for fat content by the Babcock method *(1)*. The remainder was held at −18° C. until analyzed for specific gravity *(1)* and carotenoid and vitamin A content *(4)*.

Standard statistical procedures *(7)* were used to determine possible differences. Two cows, which had rectal temperatures in excess of 106° F., refused to consume appreciable amounts of the artificially-dehydrated ground and pelleted form of the alfalfa. Missing values for these particular periods were calculated by an iterative method *(9)*.

## RESULTS AND DISCUSSION

Feeding the artificially-dried and chopped form of alfalfa resulted in the greatest carotenoid intake per cow per day (Table 1). This was accompanied by higher levels of carotenoids ($P < 0.001$) and vitamin A ($P < 0.001$) per unit of milk secreted, as well as higher concentrations of these substances in the milk fat ($P < 0.001$ for carotenoids and $P < 0.01$ for vitamin A) than those observed for the other two forms of alfalfa. The total number of milligrams per day of these substances secreted in the milk was also greater ($P < 0.01$) during the chopped hay feeding period.

In contrast, the feeding of the artificially-dehydrated and pelleted form of the alfalfa resulted in slightly lower carotenoid intake than that for the chopped form but more than seven times ($P < 0.01$) that observed for the field-cured and field-baled form of the alfalfa. In spite of the wide differences in carotenoid intake between the field-baled and pelleted forms, the concentrations and total amounts of carotenoids and vitamin A in the milk did not differ markedly.

When the carotenoids and vitamin A values were equated to U.S.P. units [3] per pound, the milk of the cows fed the chopped form contained the most of those two nutrients, whereas there was little difference between these values

[3] In the calculations, 0.6 γ carotenoids and 0.3 γ vitamin A were each considered equivalent to 1.0 U.S.P. unit of vitamin A *(12)*.

TABLE 1

*Effect of form of alfalfa when fed as the sole source of roughage on the carotenoid and vitamin A content of milk*

| Criteria | Form of alfalfa | | | Standard error [a] |
|---|---|---|---|---|
| | Artificially-dried and chopped | Artificially-dried and pelleted | Field-cured and field-baled | |
| Carotenoid intake *(mg./cow/day)* | 801 | 717 | 96 | ±16 |
| Carotenoid concentration of milk *(γ%)* | 61 | 42 | 47 | ±1 |
| Vitamin A concentration of milk *(γ%)* | 19.8 | 16.2 | 17.2 | ±0.5 |
| Carotenoid concentration of fat *(γ/g.)* | 12.4 | 9.6 | 9.8 | ±0.3 |
| Vitamin A concentration of fat *(γ/g.)* | 4.08 | 3.74 | 3.62 | ±0.10 |
| Total carotenoids in milk *(mg./day)* | 8.59 | 5.68 | 6.49 | ±0.31 |
| Total vitamin A in milk *(mg./day)* | 2.79 | 2.25 | 2.35 | ±0.09 |
| Vitamin A potency of milk *(U.S.P. units/lb.)* | 740 | 546 | 596 | ±15 |
| Per cent of carotenoid intake in the milk *(log 10 times % U.S.P. units of vit. A)* | 1.227 | 1.132 | 2.054 | ±0.031 |
| (Antilog/10 in % or geometric mean) | 1.68 | 1.35 | 11.33 | —— |

[a] Standard error of a mean, derived from the square root of the error mean square divided by the square root of 18, the number of cows used in the experiment *(7)*.

for the milk from the cows fed the field-baled and the pelleted forms ($P < 0.001$ for the chopped versus the pelleted or baled).

The apparent transfer of U.S.P. units of vitamin A equivalent from feed into milk was significantly different ($P < 0.001$) among the three forms of alfalfa. Although the carotenoid intakes were approximately the same when the chopped and pelleted forms were fed, the percentage transfer was greater ($P < 0.05$) during the chopped-hay feeding period. The greatest transfer of carotenoids present in the alfalfa was observed to occur during the ingestion of the field-baled form. The expected vitamin A content of the butter for each cow during the feeding of each form of alfalfa was calculated from the carotenoid intake by the formula of Wiseman *et al. (25)* ($Y = -12{,}912 + 8{,}937X$ in which Y = I.U. of vitamin A per pound of butter, and X = logarithm of the milligrams of carotenoid intake per cow per day). The observed values deviated from the expected by +550, −1,247, and +6,739 I.U. of vitamin A per pound of butter for the chopped, pelleted, and field-baled forms, respectively. These differences were found to be statistically significant ($P < 0.001$).

The apparent high mammary secretion of the ingested carotenoids of the field-baled forms was expected. Previous workers have shown that on low intakes of carotenoids and/or vitamin A the efficiency of utilization for mammary transfer was generally greater than at higher intakes *(8, 21, 25)*. On low intakes of carotenoids and vitamin A, body stores of carotenoids and vitamin A have

been demonstrated to contribute to the mammary product *(8)*. Forty-day feeding periods have been reported to be of sufficient duration to produce a measurable change in carotenoid and vitamin A content of milk *(11)*, but they did not reflect carotenoid intakes.

The average milligrams of carotenoids ingested per cow per day during Periods I,[4] II, and III were 580, 564, and 468; the micrograms of carotenoids per 100 ml. of milk, 47, 51, and 51; the micrograms of vitamin A per 100 ml. of milk, 16.8, 18.0, and 18.4; the micrograms of carotenoids per gram of milk fat, 10.1, 11.1, and 10.8; the micrograms of vitamin A per gram of milk fat, 3.65, 3.88, and 3.91; the total milligrams of carotenoids in the milk, 7.65, 7.01, and 6.12; the total milligrams of vitamin A in the milk, 2.72, 2.42, and 2.24; the U.S.P. units of vitamin A per pound of milk 593, 642, and 647; and logarithms of ten times the per cent of the intake of carotenoids in U.S.P. units, 1.498, 1.456, and 1.470. These results, which agree in general with those recently reported for lactation trends of carotenoid and vitamin A content of milk by Chanda *(5)*, represented the period in lactation when the rates of change of these constituents approached the minimum.

It appears from these data that the physical state of the roughage fed affected the mammary utilization of carotenoids and vitamin A. Fineness of grinding of roughages has been reported to have variable or no effect on digestibility *(23)* and possibly to affect the rate of passage through the digestive tract *(2)*. One study with sheep *(15)* indicated no differences in TDN content between the chopped and pelleted forms of third cutting dehydrated alfalfa. An alteration of the end products of digestion, such as a change in the proportion of the short-chained fatty acids *(22, 24)*, may have occurred which in some manner might have affected utilization of the ingested carotenoids.

## SUMMARY

The effect of feeding artificially-dried and chopped, artificially-dried and pelleted, and field-cured and field-baled forms of alfalfa as the sole source of roughage on the carotenoid and vitamin A content of the milk was studied using 18 Guernsey cows in a double change-over design. During the feeding of the chopped form, carotenoid and vitamin A concentration of the milk and of the milk fat, as well as total amounts of these constituents secreted, were found to be significantly greater than those for the field-baled and pelleted forms of the alfalfa. Although the carotenoid intake when feeding the pelleted form was of approximately the same magnitude as that for the chopped form and more than seven times greater than that for the field-baled form, the carotenoid and vitamin A content of the milk was less than that observed for the chopped form and approximately the same as that for the field-baled. Apparent mammary transfer of the ingested carotenoids was least during the feeding of the pelleted form of alfalfa and greatest for the field-baled form. The estimated vitamin A content of the butter as calculated from the carotenoid intakes during the

[4] The average week in lactation at the beginning of Period I was 7.1 ± 0.5.

feeding of each form of the alfalfa was approximately similar to the observed values for the chopped form, considerably lower for the pelleted form, and higher for the field-baled form.

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# THE DESTRUCTION RATE OF PSYCHROPHILIC BACTERIA IN SKIMMILK

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The advent of every-other-day delivery and the shift in marketing practice from home delivery to store purchase necessitate longer storage of pasteurized milk at 33 to 47° F. prior to use. The discontinuance of Sunday milk plant operations in many areas and the practice of every-other-day pickup in some markets also increase the storage period of the raw milk at refrigerator temperatures. These practices are conducive to the growth of psychrophilic bacteria.

The presence and growth of these organisms in milk is a well established fact *(2, 3, 4, 5, 7, 11, 13, 14, 15)*. Some controversy, however, exists as to their mode of entrance into the bottled pasteurized milk. Since many psychrophilic organisms are indigenous to natural water supplies, they may be added to pasteurized milk via the residual rinse water remaining in the sanitized bottle. They also may be added to the milk by improperly cleaned equipment or by properly cleaned and sanitized equipment which has been recontaminated with potable water containing psychrophilic bacteria.

The presence of these organisms in pasteurized milk also has been attributed to their heat resistance and ability to survive the pasteurization process. The ability of some psychrophilic bacteria to survive the low-temperature long-time (LTLT) method of pasteurization has been demonstrated by several workers *(4, 5, 7, 11)*. Because of technical difficulties, only a few studies on the thermal resistance of these organisms to the high-temperature short-time (HTST) process have been reported. In a carefully controlled study Rogick and Burgwald *(12)* were unable to detect any psychrophilic organisms in 4.1 ml. of aseptically sampled milk plated immediately after pasteurization at 161° F. for 16 seconds; after storing the pasteurized milk for 7 days at 39 to 45° F., however, the average psychrophile count was 59,000 per milliliter. In view of the practical difficulties involved in determining the thermal resistance of microorganisms to HTST pasteurization in the laboratory, an attempt was made in this study to determine the heat resistance of psychrophilic bacteria based on thermal destruction rates. Such data may be used to calculate the $z$ value and to construct the thermal death time curve *(1)*. The resulting thermal death time curve may then be compared to the theoretical pasteurization curve to predict the destruction or survival of the test organism to HTST pasteurization. Thermal rate of destruction data are presented for two psychrophilic bacteria.

## EXPERIMENTAL METHODS

The first phase of this work was a study of the extent and development of psychrophilic bacteria in milk from seven different milk plants. In five instances, single samples of raw and pasteurized milks were examined. All of the raw

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milk samples were taken directly from the storage vats; insofar as was possible, the pasteurized samples were obtained from the same lots of milk from which the raw samples were taken. The pasteurized milk samples were collected in plant-sanitized glass bottles or paper cartons as they were discharged from the filler. In two of the plant studies, filler samples were taken over an extended period to obtain some information as to the average number of psychrophiles initially present in pasteurized milk; four consecutive cartons were taken from the filler at each sampling. The samples were stored at 47° F. and examined at 1, 3, 8, and 15 days to study the development of these bacteria in milk. Psychrophilic plate counts were made in duplicate, using tryptone glucose extract agar plus 0.2% yeast extract (TGEY). All psychrophilic plates were incubated at 47° F. for 7 days.

The destruction rate studies were carried out in a thermal death time apparatus similar to that used by Malin *(8)* in studying the heat resistance of bacterial spores. This apparatus is shown diagrammatically in Figure 1. The heating unit consisted of a large Unitherm constant temperature water bath

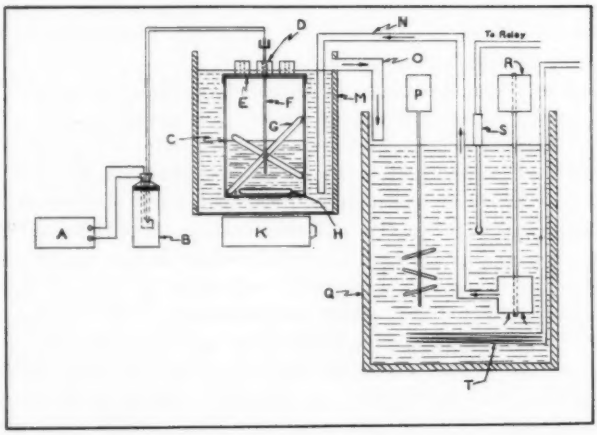


FIG. 1. Schematic diagram showing apparatus used in the thermal death time studies: *A* potentiometer, *B* reference junction, *C* test chamber, *D* sampling vent, *E* rubber diaphragm, *F* thermocouple needle, *G* baffle, *H* agitator bar, *K* magnetic agitator, *M* 4-liter beaker, *N* intake line, *O* overflow, *P* agitator, *Q* constant temperature bath, *R* immersion pump, *S* mere-to-mere thermoregulator, *T* heating coil.

containing an immersion-type centrifugal pump to circulate the heating medium to a 4-l. beaker containing the test chamber. The test chamber, per se, consisted of a cylindrical stainless steel container fitted with a rubber diaphragm and circular steel disc with seven sampling vents 0.75 in. in length to permit complete immersion of the test chamber in the heating medium. A screw-type closure ring was used to obtain a water-tight seal. A glass baffle and magnetic agitator bar were placed inside the test chamber to provide agitation throughout

the heating period. The entire chamber was submerged in the 4-l. stainless steel beaker in such a way that a magnetic stirrer under the beaker rotated the agitator bar.

The destruction rate studies were carried out in skimmilk at three temperatures. The temperature of the skimmilk test medium in the chamber was determined, using a Rubicon potentiometer; a thermos bottle containing crushed ice and water was used as a 32° F. reference junction. The internal temperature in the center of the test chamber was obtained by means of an 18-gauge hypodermic needle sealed at the end and threaded with a copper and constantan thermocouple wire in such a manner that the lead wires touched the closed tip of the needle. The needle was filled with glycerol to provide rapid conductivity between the various parts of the thermocouple system.

The two cultures [1] used in this study were carried on TGEY agar. The test inoculum was prepared by placing 100 ml. of sterile skimmilk in a 500-ml. Erlenmeyer flask with 5 ml. of a 24-hour skimmilk culture of the organism. In order to obtain a sufficiently high yield of cells, it was necessary to incubate the culture flask at 82° F. for 24 hours on a reciprocating-type shaker having a 3-in. stroke and oscillating at the rate of 100 strokes per minute. The increased heat resistance which occurs when organisms are cultured at temperatures higher than those ordinarily used for milk storage (40 to 50° F.) provided a desirable safety factor for these tests.

In carrying out the destruction rate studies, 200 ml. of skimmilk was sterilized in the assembled heating chamber. The needle containing the thermocouple leads was sterilized in boiling water for 15 minutes and inserted into the center sampling vent. At the desired temperature, 1 ml. of the skimmilk test inoculum was forcibly injected into the chamber, using a 1-ml. glass hypodermic syringe fitted with a 2-in., 18-gauge needle. Adding only 1 ml. of test inoculum provided a sufficiently high initial level of organisms but did not cause any fluctuation in temperature, as indicated by the fact that no deflection of the galvanometer needle was noted at the time of injection. The "come-up" time was, therefore, considered to be negligible in these studies. The holding time was calculated from the time of the injection of the inoculum; no samples were taken for at least 3 minutes after inoculation to permit thorough mixing. At intervals throughout the test period samples were taken for plating, using a sterile 5-ml. syringe fitted with a 6.5-in., 14-gauge needle; the needle was inserted through the diaphragm 5 seconds before the actual time of sampling to facilitate removal of the sample at the exact time. The samples were transferred to iced test tubes and held at 68° F. until plated. All samples were plated in triplicate on TGEY agar within 30 minutes after removal from the chamber and were incubated at 82° F. for 2 days.

[1] *Pseudomonas viscosa* 3 was obtained from P. R. Elliker, Oregon State College, and No. 29 was isolated from a dairy water supply and tentatively identified as *Pseudomonas mephitica*.

## RESULTS AND DISCUSSION

The results of the field survey are shown in Figure 2. The psychrophilic count on raw whole milk varied from 10,000 to 3 million per milliliter; on 20 samples taken from Plants 6 and 7 over a 15- and 5-week period, respectively, the psychrophile counts 24 hours after pasteurization ranged from less than

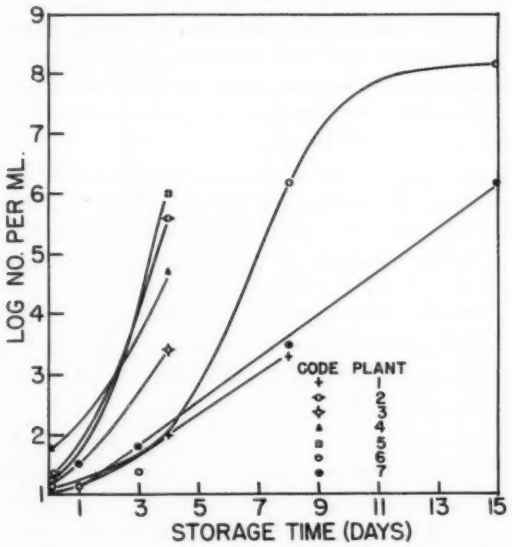


FIG. 2. Development of psychrophilic bacteria in pasteurized milk on storage at 47° F.

1 to 30 per milliliter. These counts compare favorably with the results obtained on the spot check samples taken during the field study. They also agree with results reported by Olson *et al. (9)*, who found average psychrophile counts of less than one per milliliter on samples from five plants that were rated "good." On the basis of these data, one may conclude that an initial psychrophile count of less than 10 per milliliter is obtainable under conditions of good plant operation. From a health viewpoint a nonpathogenic psychrophilic count of 10 per milliliter would not be considered objectionable. From the viewpoint of management and quality control, however, even this low level of contamination can not be tolerated if milk is to retain its good quality on storage at 47° F. for periods longer than 6 or 7 days, as 64% of the samples showed some evidence of psychrophilic spoilage on the eighth day. This was indicated by a decrease in average flavor score from 39 to 37 in milk from Plants 6 and 7. From this it is apparent that the present public health standards and recommendations for bacterial count and bacterial types are of limited value as an index to the keeping quality of milk to be kept under the usual conditions of handling in stores and homes.

The rates of growth of psychrophiles in whole milk are shown in Figure 2. Considerable variation in the rate of increase is indicated. This is particularly true of samples from Plants 6 and 7 and is undoubtedly due to the fact that different species or genera were present. This variation in the rate of increase is important in that it indicates that in freshly pasteurized milk the growth rate as well as the initial level of contamination must be considered in studying the problem of psychrophilic spoilage.

The average counts obtained from triplicate plates in the rate of destruction studies using *P. viscosa* 3 are shown in Table 1. The destruction rate curves obtained from these data, and the average *D* values calculated from the slopes of these curves are shown in Figures 3, 4, 5, and 6. It is interesting to note

TABLE 1

*Number of P. viscosa 3 surviving heat treatment at various temperatures in milk*

| | Temperature (° F.) | | | | | |
|---|---|---|---|---|---|---|
| | 122.4 | | 118.6 | | 114.2 | |
| Trial No. | Time | Av. survivors per ml. (× 1000) | Time | Av. survivors per ml. (× 1000) | Time | Av. survivors per ml. (× 1000) |
| | *(min.)* | | *(min.)* | | *(min.)* | |
| 1 | 0 | 48,000 | 0 | 48,000 | 0 | 48,000 |
| | 3 | 33,000 | 7 | 11,000 | 10 | 20,000 |
| | 6 | 1,800 | 10 | 260 | 20 | 74 |
| | 9 | 2 | — | —— | 25 | 1.6 |
| | 0 | 51,000 | — | —— | 0 | 51,000 |
| | 3 | 51,000 | — | —— | 5 | 56,000 |
| | 5 | 23,000 | — | —— | 8 | 55,000 |
| | 7 | 4,000 | — | —— | 10 | 32,000 |
| 2 | 9 | 85 | — | —— | 15 | 8,100 |
| | — | —— | — | —— | 18 | 2,200 |
| | — | —— | — | —— | 20 | 780 |
| | — | —— | — | —— | 25 | 63 |
| | 0 | 47,000 | — | —— | 0 | 47,000 |
| | 3 | 37,000 | — | —— | 8 | 32,000 |
| | 5 | 16,000 | — | —— | 10 | 19,000 |
| | 7 | 89 | — | —— | 15 | 4,300 |
| 3 | 8 | 40 | — | —— | 18 | 450 |
| | 9 | 2.5 | — | —— | 20 | 150 |
| | — | —— | — | —— | 25 | 15 |
| | — | —— | 0 | 54,000 | — | —— |
| | — | —— | 5 | 46,000 | — | —— |
| | — | —— | 7 | 18,000 | — | —— |
| 4 | — | —— | 8 | 6,700 | — | —— |
| | — | —— | 10 | 530 | — | —— |
| | — | —— | 12 | 30 | — | —— |
| | — | —— | 14 | 2 | — | —— |

that the survivor curves obtained in each instance are sigmoid in nature. Similar observations have been reported by others *(6, 11, 16)*.

The *z* value of each organism was determined from the slope of the curve obtained by plotting the logarithm of *D* versus the corresponding temperature

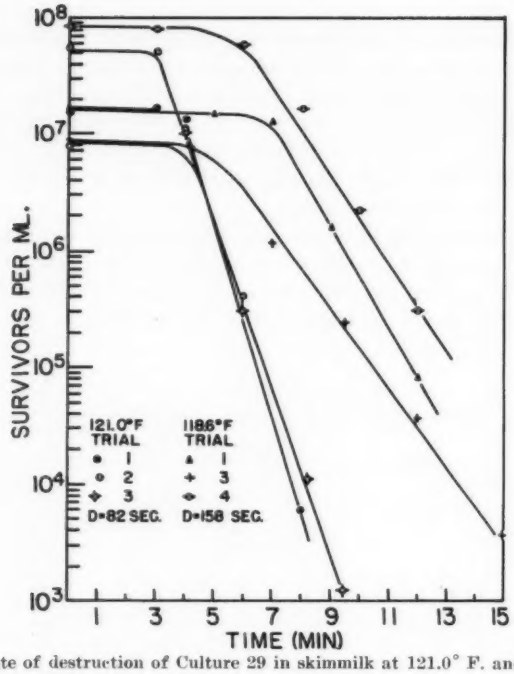


FIG. 3. Rate of destruction of Culture 29 in skimmilk at 121.0° F. and 118.6° F.

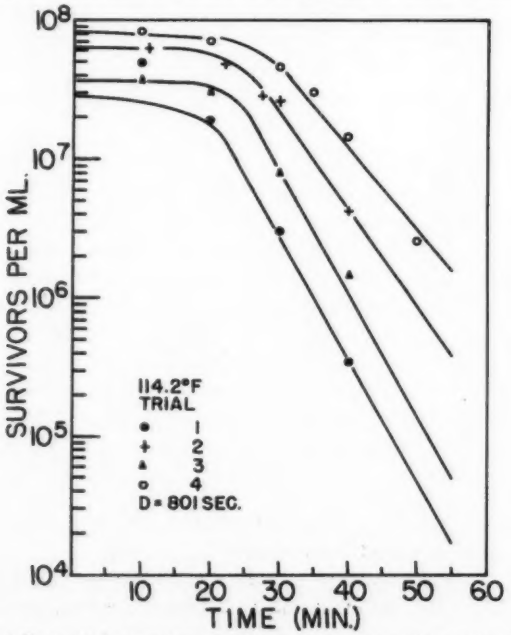


FIG. 4. Rate of destruction of Culture 29 in skimmilk at 114.2° F.

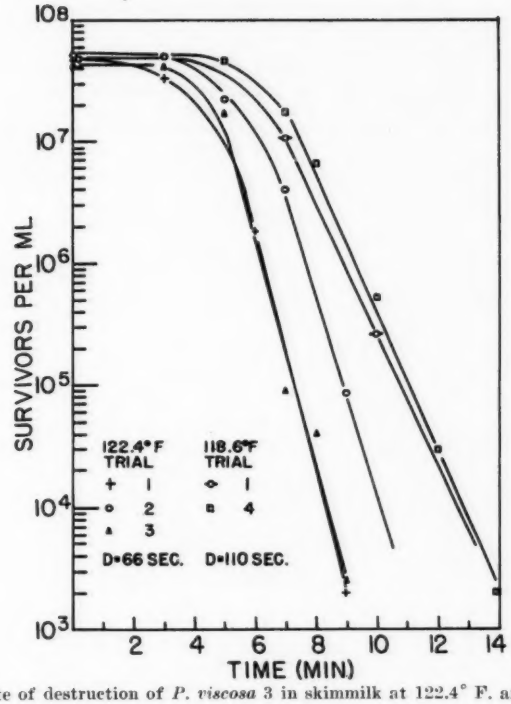


FIG. 5. Rate of destruction of *P. viscosa* 3 in skimmilk at 122.4° F. and 118.6° F.

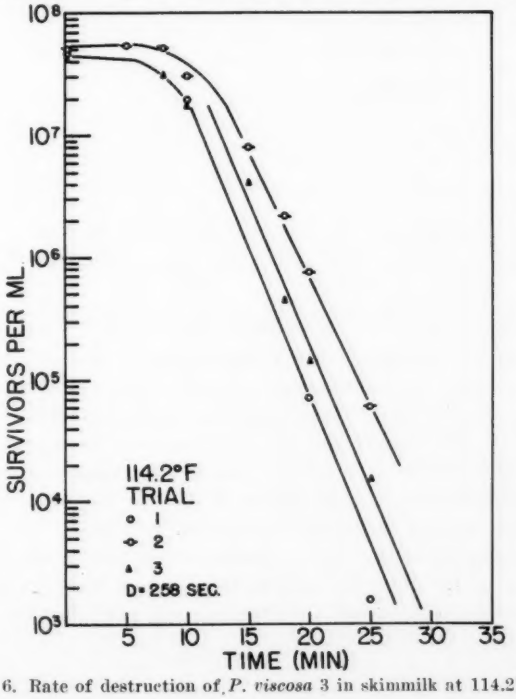


FIG. 6. Rate of destruction of *P. viscosa* 3 in skimmilk at 114.2° F.

TABLE 2

*Summary showing time required to obtain 99.999999% destruction of Culture 29 and P. viscosa 3*

| Experiment No. | Temp. | Initial No. (× 100,000) | Time required for 99.999999% destruction |
|---|---|---|---|
| | (° F.) | | (sec.) |
| | | *Culture 29* | |
| 1 | 121.0 | 160 | 683 |
| 2 | | 560 | 730 |
| 3 | | 79 | 748 |
| Av. | | | 720 |
| 1 | 118.6 | 160 | 1260 |
| 3 | | 79 | 1364 |
| 4 | | 830 | 1440 |
| Av. | | | 1354 |
| 1 | 114.2 | 160 | 4850 |
| 2 | | 560 | 6100 |
| 3 | | 79 | 5360 |
| 4 | | 810 | 7160 |
| Av. | | | 5868 |
| | | *P. viscosa 3* | |
| 1 | 122.4 | 480 | 695 |
| 2 | | 510 | 700 |
| 3 | | 470 | 685 |
| Av. | | | 693 |
| 1 | 118.6 | 480 | 1040 |
| 4 | | 540 | 1030 |
| Av. | | | 1035 |
| 1 | 114.2 | 480 | 2160 |
| 2 | | 510 | 2170 |
| 3 | | 470 | 2370 |
| Av. | | | 2230 |

at which $D$ was determined. These curves are shown in Figure 7. The formula method of Ball *(1)* also was used to calculate the $z$ value as follows:

$$z = \frac{T - T'}{\log (X'_{100} - D' \times \log a/100) - \log (X_{100} - D \times \log a/100)}$$

In this formula $T'$ represents the temperature of the reference curve (the reference curve is the rate of destruction curve determined at the lowest temperature), $X'_{100}$ represents the time in minutes during which there is no reduction in number of cells, $D'$ is the reciprocal of the slope of the destruction rate curve, and $a$ is the percentage of original number of organisms surviving at the selected level of destruction. The values of $T$, $X_{100}$ and $D$ have corresponding meanings for any rate of destruction curve in the series.

Using the graphical method, the $z$ values for culture 29 and *P. viscosa* 3 were 6.7 and 14.3; using the formula method, the $z$ values were 7.4 and 15.5, respectively. The curves represented by these slopes are phantom thermal death

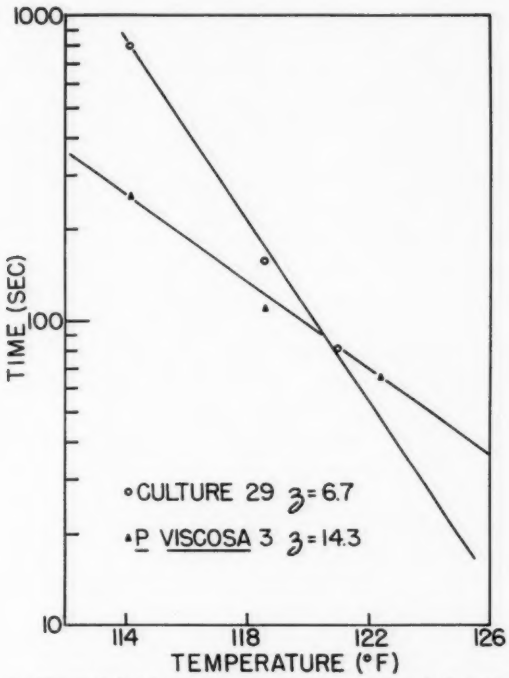


FIG. 7. Thermal death time curves of Culture 29 and *P. viscosa* 3.

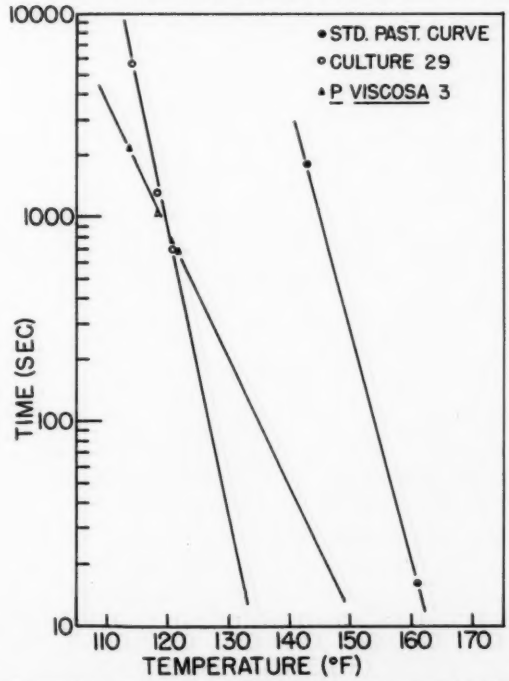


FIG. 8. Comparison of *z* curves with standard milk pasteurization curve.

time curves, in that they have direction but not position; it therefore becomes necessary to determine the position of the curves to compare them with the pasteurization curve. This can be done by determining the maximum initial level of contamination which milk can tolerate and still not undergo spoilage for the desired storage period. Since in our studies made on samples from Plants 6 and 7 the psychrophile count on whole pasteurized bottled milk 24 hours after pasteurization averaged less than 10 per milliliter in both instances, and since the average flavor scores after 8 days storage still were such as to indicate the milk was commercially acceptable, it was decided to select for the purpose of locating the $z$ curve a contamination level of 10 organisms per milliliter.

Technical reasons necessitated the high initial level of organisms used in this study; the initial counts ranged from 7,900,000 to 56,000,000 per milliliter. In order, therefore, to obtain the desired level of approximately 10 survivors per milliliter it was necessary to assume 99.99999% destruction. The times required to obtain this level of survivors are shown in Table 2. From these data the position of the thermal death time curve was determined and comparisons made with the standard milk pasteurization curve. The results are shown in Figure 8. Since neither $z$ curve crosses the standard pasteurization curve, the lethality of the pasteurization process is sufficient to kill these two organisms. The margin of safety, however, is smallest with *P. viscosa* 3, using the HTST process. Two factors tend to shift the position of the $z$ curve and reduce the margin of safety. One of these is excessively high psychrophilic contamination in the raw supply; under comparable conditions the higher the initial count, the smaller the margin of safety. The degree of destruction also affects the position of the $z$ curve; the greater the percentage destruction desired, the smaller the margin of safety. Assuming an initial contamination level of 50 million per milliliter and a 99.999999% kill (this is equivalent to a survivor level of less than one per milliliter) does not change the position of the $z$ curve sufficiently for Culture 29 or *P. viscosa* 3 to permit them to survive the HTST pasteurization process. The wide range in $z$ values shown by these two organisms indicates varying degrees of heat resistance among psychrophilic bacteria. It is conceivable, therefore, that some psychrophilic organisms might have the resistance necessary to survive the HTST process if whole milk is used as the heating medium. Studies along these lines are being continued.

## CONCLUSIONS

An average initial psychrophile count of less than 10 per milliliter can be readily obtained under good practical plant operating conditions. The rate of growth of psychrophiles varies considerably; the growth rate of the contaminating organism may be more important in determining the storage period than the initial level of contamination.

The $z$ values for psychrophilic bacteria vary considerably; for Culture 29 and *P. viscosa* 3 the $z$ values were 7 and 14, respectively. Culture 29 is readily destroyed by both pasteurization procedures. *P. viscosa* 3 is also destroyed by

both processes, but the margin of safety with the HTST process is considerably less when skimmilk is used as the heating medium.

The survivor curves for the vegetative cells used in this study show an initial deviation from linearity.

ACKNOWLEDGMENT

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# FIBER DIGESTION USING THE MINIATURE ARTIFICIAL RUMEN

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As roughage utilization is probably the most important rumen function, it is essential for nutritionists to know more about the factors affecting fiber digestion in the rumen. Since the ruminant is an expensive experimental subject for use in preliminary investigations, several types of artificial rumens have been devised for in vitro studies of fiber breakdown and other problems relating to rumen digestion. One type of artificial rumen designed by Louw *(6)*, which consists of a permeable sac suspended in a water bath, has been shown to maintain a good rumen population during a 24-hour fermentation period *(1)*. However, this type of artificial rumen is large and rather cumbersome for use in routine work. The miniature artificial rumen described by Huhtanen and Gall *(2)* is a simplified adaptation of Louw's apparatus, which has been demonstrated to possess the same desirable properties of maintaining the rumen population as the larger artificial rumen and is easier to handle. It is particularly useful in routine work where large numbers of determinations of fiber digestion are desired.

## EXPERIMENTAL

*Miniature artificial rumen.* The miniature artificial rumen described in this paper has been simplified so as to consist essentially of a small cellophane sac suspended in a 4-oz. screw-cap jar which contains a solution similar in mineral composition to sheep saliva. The sac containing the substrate and rumen fluid is held in place by screwing the cap onto the sac, as shown in Figure 1. The whole artificial rumen is small enough to be placed in an incubator.

The outside bath consists of approximately 100 ml. of McDougall's artificial saliva *(7)* made with distilled water. The composition of the artificial saliva in grams per liter is $NaHCO_3$, 9.8; $Na_2HPO_4 \cdot 12H_2O$, 9.3; KCl, 0.57; NaCl, 0.47; $CaCl_2$, 0.04; and $MgSO_4 \cdot 7H_2O$, 0.12. $CO_2$ is bubbled vigorously into this solution for about 10 minutes, or until the pH is 6.6 to 7.0.

The sac consists of ordinary dialysis tubing about 6 in. in length tied at one end with a firm knot to form a sac which will hold at least 10 ml. of rumen fluid.[1] The substrate placed in the sac is 500 mg. of alfalfa leaf meal, composed of all the particles which will pass through a 40-mesh sieve. This amount of alfalfa leaf meal usually contains 150-175 mg. of fiber.[2]

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[1] The dialysis tubing was obtained from the Visking Corp., Chicago, Illinois, and is designated as Nojax cellulose casing 24/32.

[2] The meal used as a substrate was obtained from the Schoeneck Farms, Inc., Nazareth, Pa. through the Grange League Federation.

FIG. 1. Miniature artificial rumen directly after shaking during preparation (left) and after several hours of incubation (right).

The inoculum for the miniature artificial rumen is 10 ml. of rumen fluid which has been filtered through two thicknesses of fine cheesecloth, grade 80. The inoculum, containing 1.5 to 2% solids, is placed in contact with the alfalfa leaf meal inside of the sac as soon after withdrawing the rumen sample as possible. The rumen fluid and the alfalfa leaf meal are mixed by gently kneading the sac, which is then immersed in the synthetic saliva of the outside bath previously warmed to 38° C. The sac is secured by catching the open end between the rim of the jar and the lid in such a way that about ¼ to ½ in. of the sac remains outside of the jar after the lid has been screwed in place. The whole artificial rumen is then placed in a 38° C. incubator for 16 to 24 hours. It is advisable to release the gas pressure after about 3 hours' incubation by unscrewing the lid of the jar. The sac is again replaced between the lid and the top of the jar, the cap screwed on firmly, and the whole apparatus shaken to remix the inoculum and substrate.

At the end of the fermentation period, the sac is withdrawn from the outer bath and the contents are washed into a 40-ml. graduated centrifuge tube. The fermentation is stopped by placing 1 ml. of approximately $2N$ $H_2SO_4$ in the centrifuge tube. The tube and its contents can then be refrigerated until it is convenient to determine the residual fiber. The negative control consists of alfalfa leaf meal from the same lot used in the test, to which is added the same quantity of rumen fluid used in the test. Fermentation is prevented by acidifying with 1 ml. of approximately $2N$ $H_2SO_4$ and refrigerating. Controls should be run with each test.

*Determination of residual fiber.* The amount of fiber digested in the alfalfa

leaf meal by the rumen organisms is determined by comparing the residual fiber after the fermentation with the amount present in the meal prior to fermentation.

The procedure used in the determination of the undigested fiber is a modification of the anthrone method of Viles *(8)*, which depends upon a preliminary extraction of the water soluble carbohydrates present in the sample followed by a conversion of the remaining carbohydrate material into a form that will react with the anthrone to give a colored product. The 0.5-g. sample in the centrifuge tube is centrifuged at low speed and the supernatant fluid is decanted. The solids are resuspended in water, steamed for about 45 minutes, and centrifuged again, and the supernate is decanted. The material then is resuspended in 40 ml. of 60% $H_2SO_4$ and allowed to stand over night at room temperature. A 1 to 25 dilution of the sample is made in 60% $H_2SO_4$, which represents a 1 to 1,000 dilution of the original sample. One-half ml. of this dilution is placed in a test tube with 2 ml. of distilled $H_2O$, to which is added rapidly, with shaking, 4 ml. of a 0.1% solution of anthrone in concentrated $H_2SO_4$. The mixing is necessary to avoid uneven color development by anthrone. For this reason it is also wise to use a rack that allows the tubes to be widely separated.

The contents of the test tube are allowed to cool for about 15 minutes and read in a Beckman Du spectrophotometer at 625 m$\mu$ wave length or in a Lumetron colorimeter using a 650 m$\mu$ wave length red filter. The Lumetron colorimeter or a similar colorimeter is recommended for its simplicity and the ease of handling many samples. The color produced is compared with standards containing 50, 75, and 100 $\gamma$ of pure cellulose obtained from absorbent medicinal grade cotton batting, dried at 80-85° C. for 4 hours, and stored in a desiccator.

The standards are prepared by weighing 50 mg. of the cotton and adding 40 ml. of 60% $H_2SO_4$. Two, 3, and 4 ml. of this solution are made up to 25 ml. with 60% $H_2SO_4$. These represent 50, 75, and 100 mg. of pure cellulose. In preparing the anthrone for use in this determination, Baker's analyzed $H_2SO_4$ meeting ACS standards should be used. Standards must be run with each determination. The water soluble sugar contained in the alfalfa leaf meal usually does not interfere with the fiber determination when rumen fluid and incubation are used, since the rumen bacteria ferment these carbohydrates at a rapid rate. Thus, when rumen fluid is used with incubation, steaming for the purpose of dissolving the soluble carbohydrate usually can be eliminated.

## RESULTS

To test the reproducibility of the miniature artificial rumen technique, an experiment was carried out in which 20 replicates were made using rumen fluid obtained in one sampling from a fistulated steer fed pasture and hay. The results summarized in Table 1 show that in this series of determinations the fiber digestion averaged 47% $\pm$ 4%. In order to test daily variations to be expected in the rumen fluid obtained from the same animal at the same time after feeding, a second experiment was set up with the miniature artificial rumen, using rumen fluid obtained 1 hour after feeding from a fistulated steer fed hay

TABLE 1

*Reproducibility in miniature artificial rumen of fiber digestion using one sample of rumen fluid*

| Sample | Fiber Digestion | Sample | Fiber Digestion |
|---|---|---|---|
| | (%) | | (%) |
| A | 47 | K | 54 |
| B | 42 | L | 50 |
| C | 39 | M | 49 |
| D | 45 | N | 49 |
| E | 47 | O | 49 |
| F | 53 | P | 42 |
| G | 49 | Q | 40 |
| H | 44 | R | 50 |
| I | 49 | S | 50 |
| J | 47 | T | 45 |
| | | Average | 47 |
| | | Standard deviation | 4 |

TABLE 2

*Reproducibility of fiber digestion in miniature artificial rumen using samples of rumen contents taken from same animal at different times over a 2 months' period*

| Date | Fiber digestion | Date | Fiber digestion |
|---|---|---|---|
| | (%) | | (%) |
| 6-16-53 | 41 | 7-22-53 | 43 |
| 6-23-53 | 49 | 7-31-53 | 48 |
| 7-7-53 | 47 | 8-6-53 | 50 |
| 7-14-53 | 43 | 8-11-53 | 50 |
| 7-16-53 | 41 | 8-14-53 | 50 |
| | | Average | 46.2 |
| | | Standard deviation | 3.8 |

and pasture. Ten samples were taken at approximately weekly intervals. The data recorded in Table 2 show that the rumen fluid obtained under these conditions gave an average fiber digestion of 46.2% ± 3.8%.

Rumen digestion depends almost entirely upon the microorganisms which are present in the rumen. Therefore, in order for the results obtained from any artificial rumen to be significant, the apparatus must be capable of maintaining true rumen organisms during the whole fermentation period in approximately the numbers in which they are usually found in the rumen. The miniature artificial rumen has been shown to be capable of maintaining the rumen bacteria that could be grown and identified by methods previously reported, *(3, 4, 5)*, during the period of active fermentation, in approximately the same proportions as they are found in the rumen. The results of bacterial studies are presented in Table 3. The protozoa were still motile at the end of the fermentation period.

The studies showing that the miniature artificial rumen technique for determining fiber digestion is reproducible and that the apparatus appears to maintain the rumen population, recommend it as a laboratory screening pro-

TABLE 3

*Organisms isolated from original rumen fluid inoculum and from miniature artificial rumen after 24-hour fermentation*

| Trial No. | Types of organisms isolated from top dilutions of rumen contents RO— | |
|---|---|---|
| | Original | After fermentation |
| 1 | H, HD, PR, L, 6TBR | H, HD, L, 6TBR, PR |
| 2 | H, HD, 6TBR | H, HD, L, 6TBR, PR |
| 3 | H, HD, 6TBR, L, PR | H, HD, T, 6TBR, L |
| 4 | HD, H, 6TBR, PR | HD, 6TBR, H, T |
| 5 | HD, 6TBR | HD, 6TBR, PR |
| 6 | H, HD, 6TBR | H, L, 6TBR |
| 7 | H, HD, 6TBR | H, 6TBR |
| 8 | H, HD, 6TBR | H, 6TBR, HD |
| 9 | 6TBR, HD | SCC?, HD, H, 6TBR |
| 10 | H, HD, T, 6TBR | 6TBR, HD, PR |
| 11 | 6TBR, LCC, C8, L | H, 6TBR, HD, L, C8 |

cedure for the study of many practical animal husbandry problems concerning factors influencing fiber digestion and other phases of rumen digestion.

For example, the effect of antibiotics upon fiber digestion in the rumen has been the subject of much interest, and an experiment was conducted using the miniature artificial rumen to determine the in vitro effect of two antibiotics, penicillin and aureomycin, commonly used in animal feeds, on fiber digestion by the rumen flora. The experiment consisted of three trials using each of the two antibiotics at several levels to determine the degree of inhibition of fiber digestion by the antibiotics tested. The data are presented in Table 4. Both of

TABLE 4

*Effect of antibiotics on fiber digestion using miniature artificial rumen*

| Na penicillin G units/ml. (1667 units/mg.) | Fiber digestion (%) | | |
|---|---|---|---|
| | *1* | *2* | *3* |
| 5.0 | 16 | 28 | 20 |
| 2.5 | 24 | 31 | 36 |
| 1.25 | 28 | 42 | [a] |
| 0.625 | [a] | 46 | 32 |
| 0.312 | 33 | 42 | 30 |
| 0.0 | 42 | 43 | 41 |
| **Aureomycin HCl Crystalline** | **Fiber digestion** | | |
| *(γ/ml.)* | *(%)* | | |
| | *1* | *2* | *3* |
| 5.0 | 23 | 12 | 32 |
| 2.5 | 33 | 23 | 30 |
| 1.25 | 35 | 30 | 40 |
| 0.625 | 31 | 36 | 40 |
| 0.312 | 35 | 47 | 47 |
| 0.0 | 48 | 51 | 53 |

[a] Not done.

the antibiotics inhibited fiber breakdown, especially at the higher concentrations. The inhibition decreased as the amount of antibiotic present diminished, and in some instances fiber digestion was as good as the control when the lower levels of penicillin were used. In addition to the data incorporated in Table 4, some experiments were run using the antibiotics, bacitracin and terramycin, at levels of 50 and 5 $\gamma$ per milliliter. The bacitracin had an activity of 43 units per milligram. The terramycin even at the lower level completely suppressed fiber digestion, and the bacitracin at both levels depressed the fiber digestion more than half. Wasserman *(9)*, using filter paper for cellulose found that 15 units per milliliter Na penicillin G inhibited cellulose digestion in the artificial rumen, whereas 7.5 units per milliliter seemed to stimulate cellulose digestion.

Another important use of the miniature artificial rumen is to test the efficiency of the fiber digesting ability of the rumen organisms found in the rumen fluid of animals fed various rations. The preparation of a miniature artificial rumen for each animal sampled in the field has become a routine procedure in studying the effect of ration on the fiber digesting ability of the rumen flora. Table 5 shows the results from one series of field experiments. Four

TABLE 5

*Fiber digestion in the miniature artificial rumen using rumen fluid from cattle at Michigan State College fed roughage with and without starch and lactose*

| | Ration | | |
|---|---|---|---|
| Cow No. | Roughage alone | Roughage + starch | Roughage + starch + lactose |
| 741 | good | poor | negative |
| 707 | good | fair | poor |
| A26 | good | fair | fair |
| A55 | good | negative | poor |

Good = 40% digestion and above.
Fair = 20-39% digestion.
Poor = 10-19% digestion.
Neg. = below 10% digestion.

fistulated cattle at Michigan State College were fed a ration of good roughage for a period of 60 days. Then 5 lb. of starch were added to the ration for a period of 60 days, and finally a mixture of 0.85 lb. lactose and 4.15 lb. starch was fed to these cattle for an additional 60-day period. Rumen samples were taken just prior to the change in ration at each of the three periods, and miniature artificial rumens were prepared with the rumen fluid from each animal. The results recorded in Table 5 show that during the period when the animals were eating roughage alone, good fiber digestion was obtained in the miniature artificial rumen. Upon addition of starch, the fiber digestion as shown in the miniature artificial rumen was lowered, and this result was found again when both the starch and lactose were present in the ruminant's ration. These findings correlate well with data obtained from digestion trials which have repeatedly shown that starch decreases the digestibility of crude fiber in the intact animal.

In applying these data to animal husbandry experiments, no attempt has

been made to assign exact quantitative values to the results of the fiber determinations. The interpretation has been made in terms of a range of values in which 40% digestion or above is considered to be good fiber breakdown; 20 to 39% digestion, fair breakdown; and 10 to 19% digestion, poor breakdown. Any value lower than 10% digestion probably falls within the limits of error of the experimental procedure and is termed negative digestion. This scale was established when it was found that 40% fiber breakdown usually occurred in the miniature artificial rumen when rumen fluid from a thrifty ruminant fed a good roughage ration was used as inoculum.

## DISCUSSION

Any in vitro apparatus, such as the artificial rumen, has both advantages and disadvantages. The substitution of a simple laboratory device for the intact animal has as its main advantages convenience and economy. The limitation is principally the very real problem of transferring results obtained in the laboratory to the intact animal. Therefore, in vitro devices find their greatest usefulness as a screening technique, with realization that the results obtained do not necessarily duplicate similar functions in the ruminant. The artificial rumen as devised by Louw is superior to certain other types of artificial rumens, since it can support a viable rumen population similar to that found in the animal during a 24-hour fermentation period. However, because of its size and the fact that continuous neutralization is necessary, this apparatus is somewhat cumbersome to work with and not particularly well suited to routine work. The reduction of the size of this apparatus was a paramount consideration in developing the miniature artificial rumen. The technique was also designed to eliminate the need for frequent neutralization. The miniature artificial rumen because of its size, ease of preparation, reproducibility, and maintenance of the rumen bacteria is ideally suited for routine determinations. It is especially useful in the field, where an individual artificial rumen can be set up for each animal to determine the ability of the whole rumen population to carry out the very important rumen function of fiber digestion. This aids greatly in evaluating the efficiency of rumen function under varying conditions of ration and animal husbandry treatment.

The miniature artificial rumen also can be used to obtain information about the breakdown of nutrients in ruminant feeds other than fiber, and the end products of digestion can be studied. Another use of the modified miniature artificial rumen is to study the fiber breakdown by pure cultures of rumen bacteria.

The development of the technique included several important factors. Previous work by Gall *et al. (1)* demonstrated the desirability of having a permeable system. Thus, the use of a dialysis sac was essential. The salt solution selected for the outside bath was McDougall's synthetic saliva *(7)*, since this had approximately the same mineral composition as the saliva which normally is secreted into the rumen in very large quantities. This solution is very strongly buffered with both phosphate and bicarbonate; thus, no neutralization is necessary during

fermentation. It is important that the cap of the bottle be screwed on tightly, however, since escaping $CO_2$ will cause an alkaline shift in the pH. Alfalfa leaf meal was chosen as the substrate because a constant supply of fairly uniform product was readily obtainable on the market in ground form.

The studies reported here have been made on the basis of decomposition of fiber which includes all forms of cellulose and related polysaccharides, rather than on the basis of cellulose digestion alone. Absolute determination of the cellulose broken down does not reflect the action of the rumen where the substrate consists of mixed carbohydrates (or cellulose and related polysaccharides) from the feeds that are being continuously decomposed together. Also, almost all digestion trials using the intact animal are conducted to determine fiber rather than cellulose digestion.

## SUMMARY

A miniature artificial rumen technique for studying fiber digestion by rumen bacteria and a method for determining fiber was described. The reproducibility, uses, and limitations of the technique were discussed. One example of the use of this technique was a study of the in vitro effect of antibiotics on the digestion of fiber by rumen bacteria. The use of the miniature artificial rumen in field work was described. Other uses of this procedure were suggested.

## ACKNOWLEDGMENT

We wish to thank C. F. Huffman of Michigan State College for his permission to use the data obtained in field studies of the rumen bacteriology of his fistulated cattle.

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# PEOPLE and EVENTS
## in the Dairy Science World

### Pioneers in the Dairy Industry

HARRY LUMAN RUSSELL's name is indelibly inscribed in the annals of dairy science, and his influence has shaped the lives of scores of dairy scientists and others who have benefited from his teaching and example.

The mention of only three of his many scientific accomplishments establishes Russell well as one of the greatest dairy scientists. It was his foresight, technical knowledge, and determination that were responsible for the introduction of the tuberculin test into Wisconsin and the Midwest. After 60 years of testing and culling, bovine tuberculosis is only a minor disease. It once threatened human lives.

**H. L. Russell**

It was Dr. Russell who worked out the conditions for proper pasteurization of milk—one of the keystones of the modern dairy industry. And, with the famed STEPHEN M. BABCOCK, Russell developed the cold curing process for cheese — a method now used by cheesemakers all over the nation.

Born in Poynette, Wis., in 1866, Russell received the B.S. degree from the Univ. of Wisconsin in 1888 and the M.S. degree from the same institution in 1890. After post-graduate work with Koch and Pasteur in Europe, he earned the Ph.D. degree at Johns Hopkins Univ. in 1892.

Then, after a year at the Univ. of Chicago, Russell was called back to the Univ. of Wisconsin. He was probably the first person employed by any institution specifically to bring this new science of bacteriology to bear directly on problems of agriculture and related industries. In 1907 he was appointed dean of the College of Agriculture and director of the Agricultural Experiment Station — posts he held for a quarter of a century. Russell was the College's second dean. His appreciation of the value of basic research guided him in the selection of men for the Wisconsin staff and in the emphasis the Wisconsin Station placed on fundamental as well as applied studies on farm problems. Graduate student teaching in agricultural fields grew rapidly at Wisconsin during Russell's administration.

In 1931 and at an age when most men think of retiring, Russell assumed directorship of the Wisconsin Alumni Research Foundation, an organization devoted to making best use of income from patents earmarked for the support of basic research. Russell retired from active management of the Foundation in 1939. During the 8 years under his direction, the Foundation's business grew from a $900 original investment to a net annual income of more than a million dollars.

Russell's greatest hobby is travel and the outdoors. He has visited every continent of the globe, every state in the Union, and all but one province in Canada. His latest large trip was in 1952, when he toured Africa's animal country by automobile. Anybody who has ever taken a trip — even a short one — with "the Dean" is instantly struck by his inquiring mind and keen powers of observation. He is never satisfied merely to see; he must learn, and record.

A few people are able to achieve recognition for outstanding accomplishment in their profession or occupation, but Russell has earned this recognition three times — first as a scientist and teacher, then as a college administrator, and finally as executive director of a new program which applies profits from patented findings to support still more research. All of his full, eventful, and fruitful life has been dedicated to the public interest.

### New Sanitary Engineering Center Building Completed

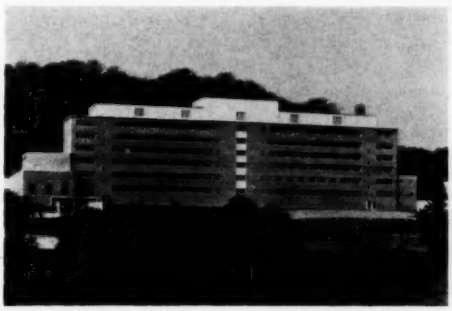
The new four million dollar building in Cincinnati, Ohio, which will house the Sanitary Engineering Center of the Public Health Service, will be dedicated by MRS. OVETA CULP HOBBY, Secretary of the Dept. of Health, Education and Welfare, on Thursday, April 8.

The Sanitary Engineering Center, until recently the Environmental Health Center, is the focal point of the federal government's research and study into how the health of human beings may be affected by contacts with elements found in air, water and food, and by radiation and other factors in the environment.

The structure is located at Columbia Parkway and Grandin Road, about 6 miles east of downtown Cincinnati and overlooking the Little

Miami River. It was authorized by the 80th Congress, in 1948, under bipartisan legislation.

Mrs. Hobby's dedication address will be part of a 2-day program opening the new research and training center. The program on the second day will include talks by four leading scientists dealing with various aspects of man's efforts to control the environmental factors affecting



**New Home for Sanitary Engineering Center**

his health. Those to be invited include leaders in the fields of sanitary engineering, the biological and physical sciences, public health, industry, and other allied professions from all of the states and territories. Scientists from universities and other research institutions also will attend.

On Thursday evening, following the dedication ceremony, a banquet is to be held at the Netherland Plaza Hotel in downtown Cincinnati, and the speaker will be DR. ABEL WOLMAN, one of the nation's leading sanitary engineers.

## New Atlas Powder Co. Plants to Produce Chemicals for Ice Cream Industry

The start of construction by Atlas Powder Co. of Wilmington, Del., of two new plants which will increase its capacity to produce mono- and diglycerides and other emulsifiers which it supplies to the ice cream, dairy, and other food industries was announced this week by KENNETH E. MULFORD, general manager of the company's Chemicals Dept. At the same time, Mr. Mulford announced the realignment of the department's sales and research groups to form a special Food Industry Division.

Larger of the two plants will be at Memphis, Tenn. It will cost more than $1,000,000 and is scheduled for completion by late 1954. It will be situated on property purchased from and adjacent to the HumKo Co., a subsidiary of National Dairy Products Corp. Atlas is at present the distributor for the fatty acids sold under the trade name, Hystrene, and produced by the Trendex Division of the HumKo Co.

The second plant, at Brantford, Ont., is being erected by Atlas Powder Co., Canada, Ltd. Its first unit, to cost about $350,000, will be in operation within 6 months. Preliminary planning has been started, looking to the addition of a second unit for the production of ethylene oxide derivatives at this location.

## Robert H. Rumler New Executive Secretary of the Holstein-Friesian Association

At the annual meeting of the board of directors of the Holstein-Friesian Assoc. it was announced that ROBERT H. RUMLER was made executive secretary to succeed HORACE W. NORTON, JR. Mr. Norton, who held that office for 25 years, recently reached retirement age. He will continue to serve as chairman of the Research Committee.

Mr. Rumler has for the past 5 years served as assistant executive secretary of the Assoc. He is a graduate of Pennsylvania State Univ. As chief administrative officer of the world's largest dairy cattle breeders' registry association, he will be in contact with a large segment of the dairy industry.

## Important Industry Problems Discussed at California Meeting

A challenging 3-day conference was concluded February 10 on the Davis campus of the Univ. of California, according to E. L. JACK, chairman of the Dept. of Dairy Industry. C. A. IVERSON, professor of dairy industry at Iowa State College and faculty guest speaker for the conference, took "A New Look at a Changing Business," and voiced the opinion that reducing butter prices a few cents a pound would keep consumption up with production and eliminate present surpluses. He did not recommend shifting any costs now allotted to butter over to nonfat milk solids. He called such a proposal impractical as long as milk solids are also in surplus, although he conceded that at present prices they are a "fantastic bargain."

E. H. PARFITT, Evaporated Milk Assoc., in discussing "The Industry's Interest in the 3A Standards Program," noted that "the coordination of efforts of fabricator, user, and official sanitarian to arrive at a common standard of sanitation in design has now been accomplished." The unification of principles of sanitation design in the minds of official sanitarians, he added, would eliminate the added costs of special designs.

"A Newer Knowledge of Milk Proteins," was discussed by N. P. TARASSUK and W. G. JENNINGS, both of the Dept. of Dairy Industry of the Univ. of California. Preliminary to a discussion of the chemical nature of proteins and the various proteins in milk, they noted that the greater part of the world's population depends mainly on low-quality plant proteins

and expressed the opinion that fortification of their proteins with certain fractions of milk protein that are rich in essential amino acids would supply a nutritionally complete protein to millions of people who otherwise suffer from malnutrition.

A symposium of five men discussed "Rancidity in the Raw Milk Supply." W. L. DUNKLEY, Univ. of California, led off with "A Statement of the Problem," a review of factors influencing the susceptibility of milk to both spontaneous and induced rancidity. L. A. KELLEY, also with the Dept. of Dairy Industry, followed with a progress report on experiments directed toward determining which parts of pipeline milkers are most troublesome in contributing to rancidity. The experimental procedure involves passing milk several times through individual sections of a pipeline milker and determining the number of passes necessary to induce rancidity.

"Experiences in Commercial Operations" concluded the symposium, with opinions on causes of rancidity contributed by three commercial representatives: S. C. MACKENZIE, of the Carnation Co., ROLAND KOHLER, of Peacock Dairies, and G. E. MORTON, field superintendent of the Arden Farms Co. Morton maintained that induced rancidity is not a problem in a properly installed pipeline where violent pumping or releasing is avoided. He listed seven factors that tend to induce rancidity in pipeline milking: homogenizing action (at undetermined milk temperatures) of both the centrifugal pump and vacuum releaser; use of vacuum exceeding 15 in.; ingress of air at the teat cup claw or bowl; risers in the line ahead of pump or release point; filtering devices between the line and point of release; air temperatures that influence milk temperatures at the critical points; and various combinations of the above factors.

JESSIE V. COLES, Dept. of Home Economics of the Univ. of California, reported on a survey of family milk uses in Oakland, Los Angeles, and Sacramento. Her studies revealed an enormous untapped market for fluid milk in nondrinkers and minimum users, who could more than dispose of surpluses by becoming only moderate users.

In a symposium on cleaning dairy equipment, S. A. KAUFFMAN, Borden Food Products Co., discussed "Spray Cleaning of Evaporators." He called spray cleaning the modern way, because it does a better job than any other method and at the same time is substantially cheaper. He named three types of savings — on cleaning material, as eliminating evaporation cuts down water use; on power, as it is unnecessary to run the pan under vacuum; and on man-hours, as the pan needs no attention other than adding and discharging cleaning materials.

"The Mechanical Cleaning of Tank Trucks" appeared promising to BYRON T. DODDS, Lucerne Milk Co., because of consistently effective cleaning, labor savings, added safety, less damage to tank surfaces, and a saving in the use of cleaners. He concluded with the statement that the tanker washer should be practical for washing storage tanks in the plant itself and that his company plans to attempt this practice in the near future.

## Completed Theses

*M.S. Degree:*

E. N. FRANKEL—Specificity of lipase action in milk. Univ. of Calif.

MASSUD S. NURY—Studies in evaporated milk. Some changes effected by heat treatment enzyme action in storage. Univ. of Calif.

RICHARD BROCKMEYER—The mechanism of homogenization in relation to homogenizing efficiency. Univ. of Calif.

JACK C. TRAUTMAN—A study of ice cream shrinkage. Univ. of Calif.

B. J. SAMALA—A study of the qualities of recombined milk with coconut fat type replacement. Cornell Univ.

*Ph.D. Degree:*

LLOYD M. SMITH—The isolation, identification and configuration of the unsaturated fatty acids of milk fat. Univ. of Calif.

HUGH LIVINGSTON—Pasture investigations with special reference to the feeding behavior of the dairy cow. Univ. of Minn.

W. H. BURGESS—Milk irradiation: light transmission and reflectance; ultra-violet effects on enzymes, bacteria, and flavor; and photochemical destruction of ascorbic acid. Cornell Univ.

## Roberts Appointed to Public Health Service Advisory Board

WM. M. ROBERTS, of North Carolina State College, has been appointed to membership on the Milk and Food Sanitation Advisory Board of the Public Health Service, U. S. Dept. of Health, Education, and Welfare, it was announced by Surgeon General LEONARD A. SCHEELE. He will represent the A.D.S.A. on the Board.

Dr. Roberts becomes the twelfth member of the Board, which provides consultation and guidance to the Public Health Service in preparation and development of sanitation standards covering milk and milk products, frozen desserts, foods, and food establishments. Such standards are then recommended by the Public Health Service for adoption by states and communities.

## News from the University of Connecticut

*New Animal Industries Building*

During the fall and early winter months, the Animal Industries Dept. has moved gradually from the oldest brick building on the campus to the most recently completed building. The new Animal Industries Building houses the offices and laboratories of the Dairy Husbandry, Dairy Manufacturing, Animal Nutrition and Animal Husbandry sections. The building also houses an essentially new dairy processing plant, including dairy bar and sales room.

*New Judging Pavilion*

With the start of the second semester the new livestock pavilion of the Ratcliff-Hicks building was put in use. The new pavilion has a ring of 7,200 sq. ft. and seating capacity for 750 persons around the outside of the ring. Underneath the stands on one side of the building is located the new meats laboratory, complete from killing floor to sales room. In addition to its instructional uses, the pavilion is available for the use of state and regional agricultural organizations.

*Reproduction Short Courses Offered*

The Animal Industries Dept., in cooperation with the Animal Diseases Dept., recently conducted three short courses in the field of reproduction and artificial insemination. The first course was a basic course in the physiology of reproduction of cattle, the second was in artificial insemination techniques for the training of technicians, and the third was in artificial insemination for herdsmen. The courses had a combined enrollment of 48 and were open to anyone desiring to attend.

## Out Oregon Way

The Oregon Dairymen's Assoc. held its annual meeting in Ontario, Ore., January 7 and 8, with an attendance of 150. The association accepted a report of the promotion committee and urged that the program be put into operation. The committee was instrumental in the employment of GLENN LAY as executive secretary of the Oregon Dairy Products Commission to aid in furthering a promotion program.

Prominent members of the program included MERRILL WARNICK, president, A.D.A.; L. J. HILL, general manager, A.D.A.; and P. M. BRANDT, head, Dept. of Dairy Husbandry, Oregon State College.

MILTON RIDER was elected new president of the group, succeeding WILBUR REILING.

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The percentage of reactors in the state brucellosis control program reached an all-time low of 0.788% of the animals tested in 1953, according to H. P. EWALT, dairy extension specialist. Some 289,743 animals were tested, which includes all of the dairy cattle in the state and some of the beef cattle. The rate of reactors has shown a steady decline during the past few years with rates of 0.964% in 1952 and 1.11% in 1951.

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At its Feb. 8 meeting, the Oregon Board of Agriculture, administers of the Oregon Milk Marketing Act, found the recent controversial milk sales promotion plan of a Portland chain store to be valid. The plan, submitted by the Fred Meyer supermarket chain, consisted of awarding roller skates, radios, etc., as prizes for a children's contest in coloring All Jersey milk cartons or facsimiles thereof.

The Board had earlier submitted the plan to the State Attorney General for his opinion as to whether it violated the Fair Trade Practices regulations. This recent action of the Board was in line with the opinion handed down by the State Attorney General.

## Florida to Hold Series of Industry Meetings

Five short courses and conferences in dairy subjects will be held at the Univ. of Florida during 1954. The 23rd session of the Dairy Herdsmen's Short Course on breeding, feeding, and herd management has been set for August 10-12, with C. W. REAVES and R. B. BECKER in charge. The 19th annual Dairy Field Day, bringing to dairymen and others the results of current research and developments, will be led by S. P. MARSHALL and C. W. REAVES on September 16-17, 1954. The 17th annual Dairy Plant Operators Short Course on processing and distribution of dairy products will be held October 14-16, under leadership of L. E. MULL and P. E. BURNER (Dinsmore Dairy Co., Jacksonville). The 10th Milk Sanitarians Conference on health problems related to production and handling of milk has been set by H. H. WILKOWSKE for April 14-16. This overlaps the 5th Laboratorians Short Course on chemical and bacteriological quality control tests, led by W. A. KRIENKE and J. F. BEATTY (Foremost Dairies, Jacksonville). Eight Florida organizations, including three state departments, Florida Dairy Association, and other industry organizations cooperate in sponsoring or conducting these dairy meetings. E. L. FOUTS is head of the Dept. of Dairy Science at the Univ. of Florida, where all five meetings will be held.

## Ohio State Events

ROBERT C. MILKIE, Bellevue, Ohio, was selected by the faculty to receive the $1,380 Dairy Industries Scholarship won by the Dairy Products Judging Team in the recent contest held in Boston. He has selected Michigan State College for his graduate study.

Recent scholarship award winners in the department were ROBERT A. KAUFMAN, a senior from Wooster, and JAMES J. MINDLING, a junior from Germantown. Each received $200

awards from the Robert B. Stoltz scholarship fund for outstanding scholarship and leadership displayed during their college careers. Mindling was the first junior to receive this award. JOHN R. WISH, a sophomore from Bellefontaine, was granted an $80 scholarship by the Ohio Dairy Boosters for outstanding leadership during his first 2 years of college work.

The 3rd annual Ice Cream Short Course was held January 18-29. There were 23 participants representing production management and sales from eight states.

The 3rd annual Milk Sanitarians Short Course, sponsored cooperatively by the Ohio Dept. of Health, the Ohio Dept. of Agriculture, and the Ohio State Univ., was held March 15-19. Highlights of the meeting included discussions of C.I.P. cleaning in dairy plants, inspection techniques, pipeline milkers and bulk tanks, HTST pasteurization, laboratory practices, and farm inspections by groups. Visiting speakers included A. C. DAHLBERG, Cornell Univ.; C. A. ABELE, Diversey Corp., Chicago; and G. H. HOPSON, DeLaval Separator Corp., Poughkeepsie, N. Y.

An effective approach to the matter of acquainting high schools with the field of dairy technology is being taken by the dairy industry of Ohio in cooperation with the Dept. of Dairy Technology. This is a series of dinner meetings sponsored by local dairy groups for high school principals and counselors. At these meetings a member of the staff at the Ohio State Univ. discusses the field of dairy technology, the curriculum offered, and the opportunities for trained men. The Dayton dairy group has organized the Dayton Dairy Foundation to sponsor scholarships for deserving high school graduates in dairy technology at the Ohio State Univ.

## Deer Goes to College on Cornell Campus

According to the Journal's correspondent on the Cornell campus, R. P. MARSH, a wild deer recently invaded the laboratories of the dairy building, creating considerable excitement and some damage. As the story goes, about 8:30 one morning a small deer, estimated at 60 lb., jumped through a 14 by 20 in. pane of glass in the window of DR. HOLLAND'S market milk laboratory. The frightened animal dashed frantically about the room looking for an exit, leaving patches of blood on a corner door and on some milking machine equipment. Finally, he found his way into the corridor and was spotted by several people who tried to herd him outdoors, but he preferred to go into DR. ASDELL'S office. Professor Asdell shooed the deer back into the corridor. From there it entered the Animal Nutrition main office, then unoccupied. The deer jumped twice over a desk, breaking a fluorescent lamp and knocking over a small filing cabinet. DR. WARNER opened an outside door, and the freed animal raced away toward less populated sections of the campus. Laboratory invasions by fungi and mites have been reported in the literature but, as far as this editor knows, this is the first case of a deer invasion.

## Virginia Dairy Products Association Meets

The 39th annual convention of the Virginia Dairy Products Assoc. was held at Roanoke, Virginia, Jan. 18 and 19. REX PAXTON, director of public relations for Sutherland Paper Co., discussed "Pathway to Profits." He pointed out that the real pathway to profits and key to prosperity must depend upon strong consumer demand. A. I. TOTTEN, director of research for Reynolds Metals Co., discussed the wide application of aluminum in the dairy industry. PARKE C. BRUNKLEY, Virginia Commissioner of Agriculture, spoke on past accomplishments and future trends of the Virginia Dairy Industry. ROBERT C. HIBBEN, Intern. Assoc. of Ice Cream Manufacturers, discussed problems pertaining to the ice cream industry. LYMAN MCKEE, A.D.A. vice-president, discussed the topic, "We Have a Story to Tell."

Featured speaker was the Honorable T. COLEMAN ANDREWS, U. S. Commissioner of Internal Revenue, who explained the internal structure of the Bureau and discussed the problems related to tax collecting. The banquet address was given by KENNETH MCFARLAND, educational consultant for General Motors.

T. E. NEALE, JR. was elected president for the coming year, and C. L. FLESHMAN was elected secretary-treasurer.

## Minnesota Legislators Study Needs for Dairy Research

On Dec. 9, 10, and 11, a group of dairy legislators making up the Minnesota Interim Legislative Commission on Dairy Products and Livestock, together with board members of the Minnesota Creamery Operators and Managers Assoc. and the Minnesota Local Creameries Assoc., made a visit to Madison, Wis., in order to get firsthand information on the facilities for teaching dairy industry at that institution. The group also visited the Dairyland Coop. at Juneau, Wis.

The legislators left St. Paul on the morning of Dec. 9 and stopped first at Rochester, where they were entertained by the Rochester Dairy Cooperatives and given the privilege of inspecting their large plant. At Madison, Wis., they visited with the dairy staff members and inspected the new Babcock hall. One afternoon session was devoted to reports by the members of the College of Agriculture and other College representatives on such activities as dairy production research, dairy promotion, research on milk products, the proposed new butter grading law, and other subjects related to dairy prob-

lems having to do with both legislation and research.

On Jan. 21, the legislative group made a tour of the agricultural campus of the Univ. of Minnesota and spent a half day inspecting the facilities of the Dairy Dept. and discussing teaching and research programs with the staff.

### Minnesota Offers Special Course for Laboratory Technicians

A Milk Laboratory Technicians Short Course was offered for the second time on March 15-19. Cooperating in this training course was the Univ. of Minnesota, State Dept. of Agriculture, State Board of Health, and the U.S.P.H.S. ROBERT P. MYERS of the Environmental Health Center, Cincinnati, Ohio, was the representative of the U.S.P.H.S. on the program.

This course was offered specifically for personnel in laboratories doing testing of milk under the Grade A program. Registrants included representatives of government laboratories, private testing laboratories, and dairy plant laboratories.

### Copies of Bulletin on Sanitary Control Available

Single copies of Bulletin 250, published by the National Research Council, and entitled, "Sanitary Milk Control and Its Relation to the Sanitary, Nutritive, and Other Qualities of Milk," by A. C. DAHLBERG, H. S. ADAMS, and M. E. HELD, may be obtained without charge by writing to DR. LEROY VORIS, National Research Council, 2101 Constitution Ave., Washington 25, D. C.

### New Type Canned Milk Banned in Wyoming

The Wyoming State Dept. of Agriculture has refused to allow a group of dairymen in the Torrington area to can milk under the Winger franchise. This patented process, developed by L. T. WINGER, a Denver dairyman, is one in which hydrogen peroxide is added to the heated milk, followed by catalase. The milk is then vacuumized, homogenized, canned, and heated to 265° F. in a sterilizer. It is reported that milk is being successfully canned and marketed under the Winger franchise in other states. The refusal of the Wyoming Agricultural Dept. is based on the grounds that the state dairy laws do not include milk canned under such a special process. Under the Wyoming law a new dairy product is illegal until such a time as the State Dept. of Agriculture establishes standards for that particular product.

### Assistantships Available at California

The Dept. of Dairy Industry, Univ. of California, Davis, is offering assistantships for study toward the M.S. and Ph.D. degrees. Work toward the Master's degree is in the field of food science, and for the Ph.D. degree it may be in either agricultural chemistry or microbiology. Starting salary is $2,016 for half-time service during 9 months and full-time during July and August. Write DR. E. L. JACK, chairman, for details.

### Information Available to Dairy Cattle Breeders

The Dairy Cattle Breeding Research Council of the Purebred Dairy Cattle Assoc. has released a directory of work completed, or now in progress, at the various agricultural experiment stations, which is of interest to dairy cattle breeders. The chairman of the Council is J. W. BARTLETT of the State Univ. of New Jersey, New Brunswick. The list of studies include those pertaining to (I) Disease control and breeding trouble, (II) Improving dairy cattle through breeding, (III) Factors affecting conformation of dairy cattle, (IV) Artificial breeding of dairy cattle, (V) Milk production, and (VI) Feeding and nutrition of dairy cattle. Lists are given of the experiment stations conducting research on the specific problems included under these general headings.

### What Do Farmers Want?

Farm legislation is of vital importance to both milk producers and processors. That farmers themselves are thinking wisely on this problem is indicated by the following editorial written by CHARLES B. SHUMAN, president of the Illinois Agricultural Assoc., and published in the March issue of the I.A.A. Record, the Illinois Farm Bureau magazine.

"We favor noncompetitive disposal of the unneeded and price depressing surplus accumulations of farm products now held by government. At the same time we will work to secure changes in agricultural program legislation to prevent the recurrence of these surpluses that came through artificial stimulation of unwanted production. We are convinced that farm income will be higher when farmers once more produce for consumers rather than for government storage bins. We favor variable government price supports — not rigid price fixing.

"*Lower Farm Costs.* Farming is a competitive business with its product prices generally responsive to changes in supply and demand. We insist that stickiness in farm costs be minimized by increased efficiency and less monopoly pricing in labor and business.

"We favor gradual downward adjustment of tariff barriers, elimination of fair trade pricing laws, prohibition of industry-wide bargaining and 'feather bedding,' and strengthening rather than weakening the Taft-Hartley Act. We will attempt to secure increased funds for research work to lower the cost of producing, marketing and distributing farm products.

*"Increased Resource Conservation.* Each generation must make wise use of our natural resources for themselves and future generations. We believe this can best be accomplished by individual and local group activity and responsibility with state and federal technical assistance.

"We favor a soil conservation allotment rather than crop acreage allotments as a condition of eligibility for conservation payments and crop loans. Whenever possible, we favor the development of our land, water and power resources by private enterprise — either cooperative or non-cooperative.

*"Improved International Relations.* This is necessary if we are to have permanent world peace. We favor two-way foreign trade rather than so much dollar aid. We urge acceptance of foreign currency in payment for surplus farm products. We are convinced that healthy international trade and exchange of technical information can help prevent war.

*"Less Government.* We strongly favor reducing costs of government in all departments including agriculture. We want less government — not more. We believe in the American free choice system."

## What Industry Is Looking for in the Dairy Manufacturing Curriculum Graduate

A Guest Editorial

The small enrollment of students in the dairy manufacturing curriculum has alarmed executives in the dairy industry. Committees have been appointed and have met. Reports of committee action indicate that the lack of interest by students in the dairy manufacturing curriculum is in part due to a lack of understanding as to needs and opportunities at both the industry and academic levels. Industry has indicated that the dairy departments are training men to be teachers and research workers; the professors indicate that industry has not made the desired opportunities available for graduates.

E. H. Parfitt

During the past ten years or more, noticeable changes have taken place within the industry. Among the most important are establishment of larger production units, the merging of companies into large organizations, widespread unionization of dairy workers, development of company training programs, and the mechanization of milk and milk product processing. These changes have reduced the need for large numbers of technologists and have necessitated the employment of a limited number of men with a high degree of technical training. These changes also have prompted many of the organizations in the dairy industry to select for executive training individuals who show the aptitudes desired for an executive rather than to select individuals who have specialized in dairy technology.

In looking back to the dairy manufacturing students of 15 to 25 years ago, when the classes were relatively large, one finds many selected dairy technology because their interest was aroused by an opportunity to work in plants while attending high school or college. These summer jobs permitted the student to gain first-hand information as well as some skills. Today, primarily because of unionization and plant organization, the student generally must gain these experiences by working in the college creamery. The college creamery organization may not reflect to the student the opportunities that exist in industry.

The industry is seeking men for executive positions who have basic, rather than applied training — men who as undergraduates have had training in economics, salesmanship, public relations, engineering (chemistry), sanitation, and ability to express themselves in print or on the platform. For men in the field of routine technology the industry will continue to rely on short course students or those who have not measured up to standard in company executive training programs.

The transition that has taken place in the industry by larger units, greater mechanization, and stronger union programs, requires men with broad basic training. Today the executive of a dairy operation — the position to which the graduate from a dairy manufacturing curriculum aspires — may be one who has been trained in law, business, or basic science. Dairy manufacturing graduates in executive positions find that training as an undergraduate in applied agriculture could have been spent to better advantage in developing a background for business management, including a full appreciation of the factors which determine a company's profit and loss statements.

The formation of committees of industry and academic people to discuss industry needs and academic limitations should result in stimulating interest in the new dairy manufacturing curriculum. Industry in the future will then consider the dairy school graduate as executive material and not as a technician.

E. H. Parfitt
*Evaporated Milk Association*
*Chicago*

# LETTERS TO THE EDITOR

## President's Call to the 49th Annual Meeting

DEAR FELLOW MEMBERS AND AFFILIATES:

You are keenly aware of the forces shaping the trends of the dairy industry. These forces touch all of our interests in production, manufacturing, extension, service, teaching, and research; they affect the health and welfare of the nation. The 49th annual meeting of the American Dairy Science Association offers you an opportunity to reevaluate these forces in the light of new knowledge.

Your program committee has arranged several outstanding symposia on most timely topics. Sessions for scientific papers and practical discussions are skillfully balanced to meet your needs. Secretary of Agriculture, Ezra T. Benson, will address our opening sesssion, an auspicious beginning for an important meeting.

Those who have visited Pennsylvania State University know the beauty of the campus and its surroundings. The modern facilities now available for your comfort are exceptional. President Milton Eisenhower has personally expressed the pleasure with which he and his associates are anticipating this meeting. They are planning most carefully to make your stay a pleasant, memorable occasion.

Set aside June 22-24 for the work of your Association, for mental stimulation, professional improvement, relaxation, and friendly contacts.

WALTER V. PRICE
*President*

## A Dairy Technology Major Answers Faulkner's 12 Points

I have been following with interest the discussion of "Dairy Technology and Men," which appeared in the September issue of the Journal. I have also noted the objections raised in Dale Faulkner's letter in the November issue.

It seems to me that the discussion so far has been theoretical and abstract. It further seems to me that a more direct approach might be to make a study of men trained in the various dairy schools and find out what has happened to them since graduation, why they chose the field in the first place, and whether they would make the same choice again.

This writer chose dairy technology because he intended to enter a business which, though technical in itself, was based primarily on the dairy and food industry. With an understanding of the technical problems of these industries I hoped to better serve them and at the same time help my employer. Although I was a city boy, the dairy cow was no more mysterious to me than was freshman accounting or chemistry. The mysteries of the lactating animal were mastered, and the other required courses were duly taken, and some of the learning was retained. With a complete assortment of university courses to choose from, I elected to take courses in economics, including investments, salesmanship, business law, accounting, and mathematics, and, for the pure enjoyment of life, courses in music appreciation, family life, literature, etc., were included.

These latter courses are usually the ones taken by students in the L. A. & S. college. By taking these courses I was able to combine the benefits of a liberal education with those of a specialized training in dairy technology. This course, incidentally, included summer instruction in two universities other than my alma mater, which gave further opportunity to broaden my education.

It seems to me that with the proper background, a young man can find many opportunities in the dairy industry. I am tremendously impressed with the new frontiers that are now opening up. I feel sure that the low enrollment in the dairy technology field can be reversed by giving young men a proper understanding of these opportunities.

As for Mr. Faulkner's letter, his points are well made, but perhaps a bit pessimistic. For example, I can go through his ideas point for point and counter them. Here is how I see the dairy industry.

1. Excellent working conditions in a sanitary plant manufacturing the most healthful and one of the cleanest foods available.

2. Steady work with no sharp seasonal rises and declines where the job is not secure. In flush seasons long hours, but overtime pay involved. For laboratory and quality control men, interesting work with new challenges each day. An excellent chance to meet with the executives and help plan new equipment and better ways of doing things.

3. Rubber boots and hard floors are hard on feet and legs, but no harder than painting bridges, surveying, digging tunnels, or drilling for oil.

4. Hours no earlier than those enjoyed by motion picture stars or no later than the entertainment field — a precarious existence, economically, at least.

5. Credit given to salesmen and none to plant men or laboratory. People are usually paid for what they produce or contribute to the success of the business.

6. No rest periods during the day. This of course sounds like before the industrial revolution. No self-respecting large industry could afford this treatment today.

7. No proper place to eat lunch. This is not true of many modern plants. At any rate, think of the carpenter or bricklayer on a project out in the country without even a cold room to eat in, or the engineer 10 miles from camp at midday.

8. No lounge room. (See 6 above)

9. Smaller plants do not rely on a personnel director as most of the employees know the "boss" by his first name.

10. Lack of sick leaves, retirement plans, etc. (See 6 above)

11. Failure of company to send employees to trade meetings and maintain library for workers. This is generally done in the case of key workers or people for whom the company feels this would be of value.

12. Not enough attention given to importance of laboratory. In the past few years the laboratory really has come into its own. Without this important quality control the industry would not have progressed as far as it has.

Many college students expect to acquire a private office and a polished mahogany desk soon after graduation and to start issuing orders and memoranda to the organization. However, they must be prepared to work their way up from the bottom. Because of their hurry to get to the top in the dairy industry some may resign and seek employment in another industry. However, they will soon find that they will have to start at the bottom and go through the same tedious road.

If a survey were made of graduates or former students, it is this writer's opinion that results would be obtained that would lead to a reawakening of the possibilities of a good future in the dairy field. May I repeat, that the opportunities for an abundant life, a secure future, and a chance to apply initiative are most definitely available to the student who prepares himself properly for work in the dairy industry.

NORMAN BECK
*Los Angeles, California*

## Suggests We Eat Our Surplus Food

A recent editorial in the *Wisconsin State Journal* under date of Feb. 8, presented an enlightening article on the dairy industry. The article indicates a potential and perhaps profitable direction for the dairy industry. It also bespeaks the reaction the public may take to such a building program as we have had.

A copy of the editorial is enclosed with this letter. If you like the article, you might want to include it in the letters to the editor of the *Journal of Dairy Science*.

R. B. MAXCY
*Madison, Wisconsin*

### Our Food Surplus? Eat It!

A bespectacled, unassuming young man with a deep voice — Prof. W. C. Winder — came before a Farm and Home Week audience last week and delivered a talk that had little advance publicity and drew an audience so scanty the chairman half-apologized for it.

But Winder's address proved one of the most exciting heard all week. Day after day, speakers had warned of the alarming economic problem posed by America's burgeoning farm surplus. John Davis, an assistant secretary of agriculture who spoke from the same platform as Winder, had one eminently sensible suggestion:

"Why don't we eat it up?" he inquired.

That isn't a flippant approach to an appallingly complex issue. It is, in fact, the only practical answer. What else — in the long run — can you do with food?

But if we are going to eat our way through our "food hump" with the help of the rest of the world, ways will have to be found to make people want to buy and eat more food.

This challenge rang again and again across Farm and Home Week meeting rooms. And Winder's report on "What's New in Dairy Research" came as a dramatic reply, in terms of what Univ. of Wisconsin scientists are doing to make more people want to use dairy foods:

Entirely new kinds of cheese . . . improvements in the old kinds . . . wholly new approaches to cheese production — powdered "starters," production by machine, curing by ultra-sonic waves . . . milk "tailor-made" to fit individual needs in nutrition. . . .

Whole fluid milk that will keep in cans without refrigeration — opening markets presently inaccessible . . . better kinds of dried and frozen milk concentrates and powders — that can be shipped inexpensively . . . better-tasting ice cream.

Machines that will sell you milk right in your apartment house or on the street corner, like a newspaper . . . machines that will pour out a delicious milk shake when you drop in a coin . . . progress toward new tests that will show the nutritional value of milk instead of only its fat content.

Every one of these lines of research offers expanding markets — and expanding futures — for Wisconsin farmers and for agriculture generally.

It's proof Wisconsin is following the courageous, imaginative, wholesome concept that farmers should produce and produce well instead of artificially — and expensively — restricting production in a hungry world.

That handsome new dairy and food research building on our campus cost nearly a whopping $2,500,000.

But Wisconsin and the world may come to consider Babcock Hall a spectacular bargain.

# OUR INDUSTRY TODAY

*Brief Reviews of Current Topics*

## USE OF DEMONSTRATIONS IN DAIRY SCIENCE TEACHING

W. B. Combs
*Professor of Dairy Husbandry*
*University of Minnesota, St. Paul*

The demonstration has been employed for many years as an aid in teaching. It is effectively used by the teachers of chemistry, physics, engineering, and medicine. Industry has made the demonstration a serviceable tool in employee training and in sales. It is used at all levels of teaching. The grade teacher finds it a forceful way of impressing the pupil with certain basic principles and facts. The high school has made use of the demonstration in teaching science courses.

In 1927 some of those responsible for teaching at the University of Minnesota became impressed with the effectiveness of demonstrations, particularly in teaching short course classes.

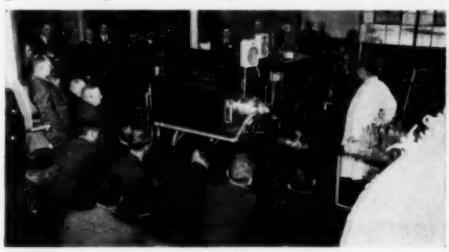

Fig. 1. Cleaning creamery equipment is best explained by demonstrating as the lecture is presented (assistants who were going through the steps are not shown).

They proved to be so successful that considerable attention was given to their development. As a result, demonstrations have become regular routine in our college teaching work. Many of these demonstrations used for the classroom have been found effective in speaking to other groups, such as women's clubs, service clubs, farm groups, home economic students, and more recently the television audience.

It is proposed here to discuss briefly a few of the demonstrations that have proven of value in teaching the first course in Dairy Science offered to agricultural students at the University of Minnesota. This course, which probably is similar to courses of this type given at other institutions, is known as "Elements of Dairying." It is offered during the freshman year and is required for students enrolled in the College of Agriculture including those who are preparing for Veterinary Medicine and Agricultural Education. Through the years, it has been the writer's privilege to develop a number of demonstrations that have aided in the teaching of this course.

Fig. 2. The color of milk and the stability of the fat are partially explained by simply dispersing a light mineral oil in water by the aid of a laboratory homogenizer.

Fig. 3. The instructor (shown in Fig. 2) is busy with his demonstration and the students pay close attention to his every word and movement.

One of the first problems of an instructor in teaching a mixed group of students is to gain their attention and interest. A subject may be a bore to a student but if a spark of interest can be created, both instructor and student will find

enjoyment in the course. One of the chief reasons for turning to the demonstration in the teaching of the beginning course was to use it as a means of creating more interest in the subject matter and thus attract more students to the field of dairying.

The demonstration is based on the axiom that "seeing is believing." This subject has been discussed in detail by speakers before the American Dairy Science Association on several occasions when subjects dealing with "college instruction" were a more prominent part of the annual convention's program (between 1927 and 1935).

### The Exhibit

Though it is expected to put emphasis here on the use of the demonstration in teaching Dairy Science courses, it should be pointed out that the exhibit can be made use of to good advantage. In presenting the course of Elements of Dairying at the University of Minnesota, the exhibit is frequently used alone or in connection with the demonstration.

It has been our experience that an exhibit of the constituents of a given quantity of milk is very effective. By placing in separate containers the exact amount of milk fat, protein (casein and albumin), sugar, ash, and water in ten gallons of milk, an impressive exhibit can be arranged. This display is then followed with one showing the total solids and water content of milk as compared with such foods as potatoes, lettuce, eggs, and tomatoes. In each instance, a definite amount (say 10 lb.) of vegetables, eggs, and milk is placed in the exhibit along with the total solids and water content in each.

FIG. 4. The speaker can make a simple exhibit of milk constituents a subject of considerable interest.

Displays such as these probably are classed as exhibits yet they do permit some action. By holding up each jar containing the milk constituents when discussing the subject it is easier to command the listener's attention. It is a very old and simple method, but it works. Action in and around an exhibit adds to its interest.

### Preparation of the Demonstration

Slides, moving pictures, sound films, charts, and exhibits, serve well in illustrating points to be made, but a live demonstration is more effective. By a "live demonstration" is meant a demonstration where either the speaker or some other person or persons perform certain acts before the audience. The demonstration is given in connection with a lecture on a given subject and should not be confused with laboratory practice work where the student learns by doing. A demonstration before an audience of any size requires planning and preparation. Every detail must be worked out in advance. It means that every need for test tubes, towels, beakers, matches, milk, and milk products, must be foreseen. There should be no interruption once the demonstration gets under way. Regardless of how simple the demonstration is, it should be rehearsed before it is presented to a class or other audience.

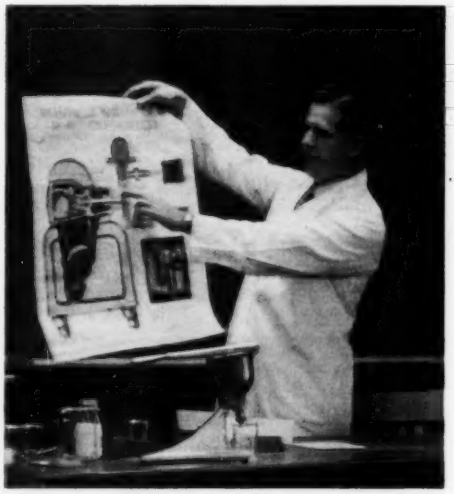

FIG. 5. The action of the homogenizer and its use by the dairy industry is explained by the use of charts and by demonstrating the action of a laboratory model.

### Keep Records on Needs

It has been found advisable to keep a record of every demonstration offered. This record designates the nature of the demonstration, a list of equipment and supplies required, comments on how the demonstration was received, and suggestions for improvement. By recording completely the information necessary to properly present a demonstration, much time and effort may be saved for one who may be called upon to substitute for the lecturer on a given occasion.

### Making Effective Use of the Demonstration

In teaching Dairy Science courses at the University of Minnesota, the lecture and laboratory system has been used, as it is in many state universities and colleges. The demonstration is

used in connection with the lecture. It has been the practice to use but one demonstration in connection with a lecture. It is generally timed to come at the last fifteen minutes of the period. The subject may be discussed in the first part of the lecture and after this presentation the point or points of the lecture are demonstrated. This means some repetition, perhaps, but it has proved to be an effective means of making clear subject matter that may be puzzling to the student. To further enlarge on this subject, two examples will be cited.

1. *How milk freezes.* — This subject may be discussed in connection with the general properties of milk. The lecture may include subject matter dealing with the effect of freezing on the physical properties of milk as well as the manner in which milk freezes. Preceding the lecture, milk in tall, straight-sided cans will be placed in the hardening room (–20° F.), and the milk allowed to partially freeze (about 60%). Afterwards, the frozen milk will be removed from the can and quickly sawed or chiseled longitudinally into two sections. These

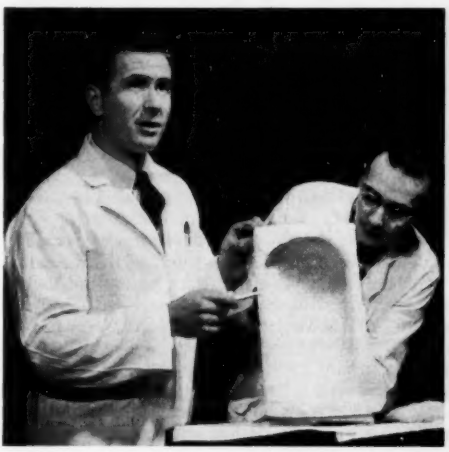

FIG. 6. A frozen block of milk placed before a group makes it possible to show clearly how milk freezes.

sections, with one unsawed block, will be exhibited in the classroom where the instructor will explain the manner in which milk freezes. The instructor can call attention to the formation of the ice crystals. He can show how the solids of milk have been entrapped in the ice crystals, how the center pocket formed contains more solids than the portion of the milk that is frozen, how the milk fat has risen and how difficult it might be to sample such milk for analyses. These are but a few of the simple points that might be discussed.

2. *The properties of casein.* — This demonstration, all or in part, has been used before Dairy Science classes on television and before many other groups. A simple exhibit of casein plastics, wool, etc., is put on display. At the appropriate time in the lecture, it is referred to. To explain and show how the development of lactic acid brings about the clotting of casein, a series of demonstrations is conducted. A flask of starter shows the natural souring and clotting of milk. The clotting of milk by the addition of a weak solution of lactic acid is shown. Applying heat quickly illustrates how heat might hasten clotting and gives emphasis to the point that milk must be sweet when processed

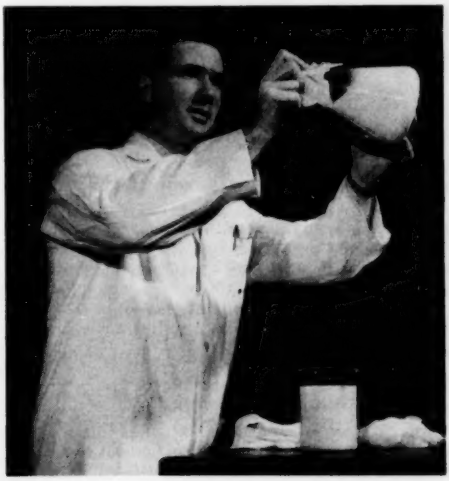

FIG. 7. By simply holding a flask of starter before a group, the instructor demonstrates the clotting of milk by acid development.

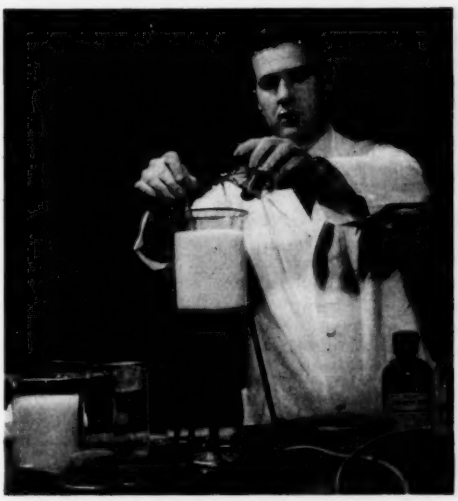

FIG. 8. Adding lactic acid to fresh milk causes clotting.

FIG. 9. Applying heat makes it possible to direct attention to how the casein can be removed. Casein and its properties make for demonstrations that are of interest to any group.

in the plant. These and other points are covered and enlarged upon as the demonstration is made.

### Present Simple Facts

In closing this discussion, the writer wishes to emphasize one very important point. Dairy Science subject matter can be made too technical for beginners. Too frequently the lecturer overestimates the understanding of the subject by the listener. It will probably surprise many readers, if they have not already learned by experience, that simple facts about dairy science are not understood by the layman, college students in the beginning class, and creamerymen. Such simple items as "whey," "buttermilk," how butter forms on churning, the action of heat on milk, and cream rising, can be made fascinating when properly explained. Simple facts about milk and its products make a story — a good story, and to make a good story better — demonstrate.

### Acknowledgment

The author is grateful for the assistance given by Howard Morris and A. W. Rudnick, Jr., colleagues, in the preparation of a majority of the photographs used in this paper.

## FLY AND RODENT CONTROL IN DAIRY PROCESSING PLANTS

T. L. HUGÉ

*The Hugé Co. and*
*American Sanitation Institute*
*St. Louis, Missouri*

The Federal Food, Drug and Cosmetic Act requires not only that food products must be free of filth but also that the plant in which the food is processed, stored, or held must be clean. The courts have defined filth as objectionable material repugnant to the general public. Manure fragments, finger nail polish, insect fragments, and rodent hairs, are examples of such filth.

Where the dairy plant, itself, or its products have been found to be in violation of this law, penalties in the form of seizures, fines, and injunctions have been meted out. The damaging effect of bad publicity resulting from such court actions is inevitable. As a result, the dairy industry has become acutely aware of the necessity for cleaner plants and for filth-free products, and this, in turn, has spearheaded a drive for better insect and rodent control.

During the last 5 years there have been major advancements in the methods and materials designed for combating flies, rats, and mice in dairy processing plants. Today, any dairy plant wishing to keep these pests under control must be conversant with these new developments in this field.

Some of the new chemicals developed in the warfare against insects and rodents have been found to be toxic to humans and other warmbloods, so extreme care must be exercised in their use.

### Fly Control

It is now commonly recognized that subsequent generations of flies are able to build up resistance or immunity to certain sprays, such as the chlorinated hydrocarbon insecticides. As mankind has developed better methods for controlling flies, the flies themselves have been able to develop better defenses against such attacks.

In controlling houseflies in and around dairy plants, certain basic factors are involved, such as: (1) elimination of fly breeding areas outside the plant where fly eggs may be deposited and matured into adults, (2) prevention of ingress into the building, (3) elimination of those that are able to gain access to processing areas.

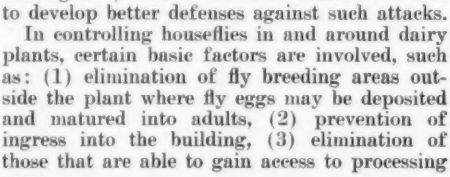

FIG. 1. Garbage made inaccessible to flies and rodents.

Flies lay their eggs in damp, nutritive material, such as milk and whey spillage around loading docks and driveways. Between rains, it should be the plant's established practice to sprinkle such breeding areas with an insecticide specifically designed to readily mix with the damp

material and to kill the eggs and larvae. Such a product would have to be water miscible, such as Lindane, with perhaps additives of methoxychlor.

An entirely new and very promising development is an organic phosphate compound, known as Malathion, which is particularly effective against strains of flies that are resistant to such materials as DDT. This material in a water base mixed with sugar is ideal for residual application to roosting areas of flies outside the plant, such as conveyor portals, and around constantly opened doors. Flies will usually crawl over or roost on certain outside surfaces before attempting to go through a doorway. The organic phosphate, applied to such surfaces, will continue to kill flies for as long as 10 days after application. Dairy plants that buy this material in concentrated form and mix a ready-to-use formulation themselves should proceed with caution. This practice embodies the dangers of handling a very toxic substance which can be absorbed through the skin and embraces the danger of incorrect mixing. It is better, therefore, to purchase a ready-to-use 2% solution of Malathion in a water base with sugar impregnated. The sugar not only acts as a synergist to the formula but also retains the flies on the treated surface long enough to effect a good kill.

There are many means of preventing flies from entering the dairy. Suffice to say, that all openings should be well screened but conveyor portals and heavy traffic doors that cannot be screened at all times present a problem.

Doorways should have self-closing devices and should be reduced in size to the very minimum. Similarly, conveyor portals should be provided with steam jets, or tunnels with their interiors painted black to discourage fly entrance. Moreover, the openings into the building that are completely unprotected at certain periods should be provided with a strong curtain of air through which the flies cannot penetrate. Such a curtain can be provided by a fly fan, which will be 95% effective if the right model is chosen and if it is installed correctly.

There is probably more misuse of fly fans than any other means of fly control in the dairy industry. It must be remembered that the fans with specially built-in deflectors will spread the air over a wider area but in so doing will reduce the velocity so that flies can easily gain entrance at floor level. It is better to use fans without deflectors but more of them if the doorway is wider than 48 in. A lighted cigarette can be used for testing a fan's efficacy at various points around the door to see whether or not there are any back currents of air which would, of course, bring flies from the outside.

Despite these precautions, many flies still will be able to gain entrance to the building on employees' clothing and on the underlips of cans. In nonprocessing areas and in rooms far removed from exposed foods, it is safe to use a residual insecticide on the walls and perhaps even on the ceilings for fly control, since there would be no danger of the wounded fly dropping into the food or equipment. For such treatments, a 3% methoxychlor and ½% Lindane insecticide in an oil base is effective.

In processing areas, the application of residual insecticide is not recommended because of the danger of dropping insects. Instead, the plant should depend on space-spraying methods using a pyrethrin or allethrin insecticide in an oil base with such additives as sulphoxide, Octicide 264, or piperonyl butoxide as synergists. Such a product should be fogged or space-sprayed so that an entire coverage of the room is made.

It is important to use a high flash-point solvent in space-spraying, as low flash-point solvents can create a definite fire hazard. It is well to be sure that the insecticide used carries the rating of Fire Underwriters' Laboratories in this respect.

In insect control, the method of application and equipment utilized are of equal importance with the insecticide chosen. The insecticide must effect not only a quick knockdown and kill but, in the case of residual materials, a long-lasting one also.

For space-spraying for control of flying insects, a spraying unit should be chosen that will break the insecticide down into particles of 15 to 30 microns.

Many insecticide sprayers, particularly those employing the Venturi principle, will produce extremely large droplets of insecticide, which precipitate and wastefully settle to the floor. For average-sized dairy processing plants, there are several electric powered sprayers that are ideal. These sprayers are equipped with timers and will produce very fine particles of spray which remain suspended in the air for long periods of time.

To apply a good residual insecticide to a surface so that the material will crystallize and continue to kill insects for long periods of time, the sprayer chosen is also very important. Of utmost significance is the nozzle, which, instead of misting or providing a cone-shaped spray, should project the insecticide onto the surface in a fan-pattern so that the treated surface can be made glistening-wet and yet not run with the liquid.

Enough cannot be said about insecticide toxicity. Management should be concerned not only about the danger of contaminating the food product but also about the danger to the worker who applies the material. Insecticides have a tendency to be readily absorbed through the skin; therefore, precautions such as washing the hands after application and the wearing of rubber gloves should be very strongly stressed. For plant use, an insecticide should be chosen which minimizes danger of food contamination

or human toxicity. Chlordane, for example, although an unusually fine residual insecticide against crawling insects, is rated more toxic, generally, than DDT.

### Rodent Control

In the control of rats and mice in a dairy plant it is important first to eliminate rodent harborages outside the building; second, to remove the rodent feeding media both outside and inside; third, to develop good rodent proofing barriers for all entrances into the plant, and, fourth, to utilize both trapping and poisoning materials and equipment inside and outside the premises.

Some of the habits and characteristics of rats are much different from those of mice, but, generally speaking, the dairy plant's rodent control program should be overhauled and ready for action at the first advent of cold weather, when these pests will attempt to seek food and shelter inside the warm building. Old lumber and scrap equipment should never be piled on the ground against the outside walls of the plant, and no food should be available in alleyways, such as unprotected garbage containers and discarded butter wrappers. All rodent harborages should be eliminated, such as false walls and double ceilings.

The plant should be considered as a fortress with all means brought into play to keep rats and mice from gaining access. Doors should be tight fitting with self-closing devices so that no light can be seen under them at floor level. Pipe and electrical conduit passageways to the building should be securely screened or sealed so that no open space remains around them. A very careful examination should be made of every square foot of the plant's perimeter up to several feet above the ground to make sure all openings are sealed. Rodents cannot live unless they are well fed, so any source of food both inside and outside the plant should be eliminated. Poison should be spread around the exterior-interior perimeter of the building. By this is meant the rooms against the plant's outside wall.

A rodenticide should be very carefully chosen and used so as to avoid all chance of contaminating the product or poisoning the workers. The use of 1080 (sodium fluoracetate) should be avoided even in locked bait boxes, unless a very serious rodent problem exists. Safe and effective rodenticides are available that, although a little more expensive or requiring more frequent application, at least divorce the plant from many of the serious hazards involved.

Until recently there were no safe rodenticides which were really effective against both rats and mice. A few years ago Warfarin, an anticoagulant rodenticide, was developed by the Wisconsin Alumni Research Foundation. This material is now available in both dry and liquid form; the dry product is much more applicable in a dairy plant. However, Warfarin has the inherent problem, because of its cornmeal and rolled oat base, of supporting insect life and mold growth, which, needless to say, are undesirable in any food processing plant. Very recently an anticoagulant rodenticide which is safe and effective against both rats and mice and which will not encourage insect life and mold growth has been developed. This product is known as Pival.

Regardless of the dry rodenticide chosen, it should be dispersed in bait boxes. These are available in either cardboard, wood, or metal. The bait boxes embrace the safety angle, provide a hidden place to feed, and supply an adequate amount of material through the feeding hoppers in the boxes. A sufficient supply is important because either Warfarin or Pival must be eaten by the rodent for 5 to 14 days consecutively.

FIG. 2. Sugar, dried milk, and other foods should be stored on pallets high enough that rodent control measures can be properly exercised.

FIG. 3. A poor method of storage.

FIG. 4. Unsealed pipe holes serve as rodent inlet to plant.

The bait boxes should be put in places which rodents frequent. This can be determined by their footprints (in flour sprinkled for that purpose), rodent excreta droppings, or gnawing. The boxes should be placed at the wall-floor juncture.

FIG. 5. Metal flashing at bottom of door makes rodent entrance difficult.

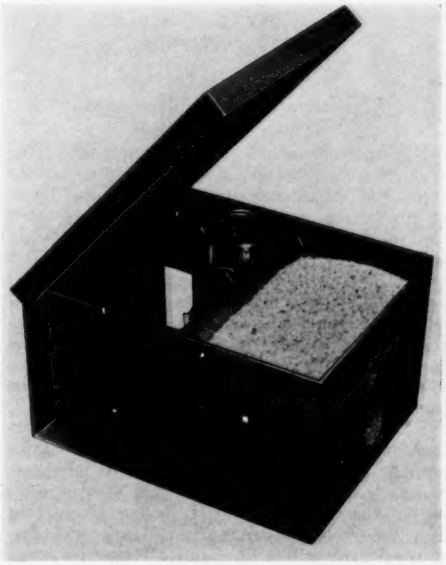

FIG. 6. Metal rodenticide bait box for dispersal of both dry and liquid bait.

Trapping, rather than poisoning, should be resorted to around exposed food and food handling surfaces, and the extended trigger principle is particularly applicable. This merely involves placing on the trigger of the trap an extended piece of cardboard or screen to enlarge the surface of the springing mechanism so that the rodent in touching the trap will spring it immediately. These extended trigger traps should be placed at right angles to the wall, preferably with a box or obstacle behind, so that the rodent traversing the wall-floor juncture almost has to contact the extended trigger and hence spring the trap.

For rats, there are specially-made metal traps that can be baited with liquids. For mice, there is a wind-up, box-like trap that is particularly effective, as it will catch as many as twenty mice in one setting without baiting.

### It Is Important to Proceed Cautiously

Again it should be emphasized that caution must be taken in using insecticides and rodenticides in any type of food processing plant. It is important that the plant operator know what is being used in his plant and whether it is safe from both the food contamination and human toxicity standpoints.

# GUIDEPOSTS FOR THE DAIRY INDUSTRY[1]

P. M. BRANDT
*Department of Dairy Husbandry*
*Oregon State College*

We dairymen are living in a new age. We have been in it longer than most of us realize because of the circumstances of its origin. These circumstances came upon us during a time when the industry was struggling to meet the problems of daily life complicated by those of a national emergency. When the emergency had passed, the first natural move was to think of rebuilding the industry on its old foundation. But the foundation was not there. So we find ourselves in this new era. It has taken time to realize this and to adjust our thinking to the changed conditions.

I have boiled down some of the most important essentials of future progress into 10 major points. They will need careful and deliberate study. No attempt is made to rate them according to their importance; it is not likely that they have the same importance in every agricultural area within the state. There are other factors that could be added — and to some they may appear more important than these that I have listed. I shall argue with no one as to the relative importance of these factors but suggest to those who may be disposed to take exception to them that, "If you have a program that you like better, work at it." There is plenty of room for constructive work for everyone on any phase of the problems presented.

The points listed cannot all be accomplished at once. Some will need research before a full program can be set up for their consummation.

1. Perfect a commercially acceptable method of testing for solids-not-fat. What appears to be a practicable testing method based on a test for protein has been developed at Oregon State College. Objectors to this test should either devise alterations to meet their objections, offer a substitute test, or accept it until a better method is found. An unwillingness to try something new should not be permitted to block industry progress.

2. The consumer must be given reliable information on the nutritional value of milk protein and the nutrient energy available in milk solids-not-fat.

3. The dairy industry must demonstrate how the consumer can get more of his protein supply from milk and milk products at relatively low cost in spite of its unique nutritional quality. There is an unlimited opportunity for the expansion of the use of dairy products on the basis of protein and nutrient energy value if the consumer is taught how to buy it.

4. Industrial use must be found for the low-quality butterfat and milk solids now spoiling the market for good quality products. The low quality products must not reach the consumer's table. The future dairy industry must be built on quality. Government research laboratories have been established with a legal obligation to find uses for these products. The acceleration of their program should be insisted upon.

5. Satisfactory progress has been made by the dairy farmers of this country in improving production per cow, but this progress must be further intensified, particularly with the aid of the artificial insemination facilities. The national goal should be a cow that will produce 12,000 lb., or more, of milk per year, containing 1,050 lb., or more, of solids-not-fat and an amount of butterfat consistent with the breed. The new era demands new standards of production based on volume of milk and solids instead of pounds of fat.

6. The quality of milk from a sanitary standpoint must be continuously improved. One quality of milk, all good enough for Grade A use, should be the goal.

7. Improved and lower cost of dairy housing goes hand in hand with better quality of milk. The capital investment in dairy farm buildings must be reduced without a sacrifice of quality in the milk produced. The increasingly high cost of labor makes imperative the adoption of labor-saving devices and improved buildings, built around this objective.

8. Public health and economy of production demand increased emphasis upon the control and eradication of livestock diseases. This will call for further restrictions on the unregulated movement of all kinds of livestock. Such restrictions are in the public interest.

9. We are in the process of inaugurating a comprehensive program of education, promotion, and advertising to increase the consumption of dairy products and bring about a broader understanding by the public of industry problems. If this program is successful, it may be wise to expand it. The extent of such expansion should be determined by the needs of the time and the success of the current program.

10. The dairy industry must become more cohesive. The new era is also one of organization. The dairy industry must protect itself against organized activities that are not in its best interests, whether originating in agricultural, business, or labor groups.

The dairy industry must be alert to both its responsibilities and its opportunities.

[1] Summary of a talk given by Professor Brandt at annual meeting of the Oregon Dairymen's Association, Ontario, Ore., Jan. 7, 8, 1954.

# OUTER-MARKET DISTRIBUTION OF MILK IN PAPER CONTAINERS IN THE NORTH CENTRAL REGION[1]

SHELDON WILLIAMS[2]

Sale of milk in paper cartons outside local markets is a trend that may have marked effect on milk distribution systems. The influence upon the industry is probably more important than the amount of milk involved. Separate and distinct markets for bottled milk have all but disappeared. The breakdown and overlapping of market areas have changed competitive conditions, the marketing structure and distribution practices.

Pasteurized and inspected milk has been made available in many new areas, and sale of milk through stores has been encouraged. These conditions have increased fluid milk consumption

FIG. 1. Nearly half the bottled milk is now sold in stores.

in many places and have stimulated the development of new outlets for packaged milk, which are especially important in periods of surplus.

A study has been made of 588 plants packaging milk in paper cartons in 13 north central states. Of these, 488 were selling paper-cartoned milk outside their local markets. The study defines the local market as everything within a line drawn five miles beyond the limits of the city or town in which the milk plant is located.

In May, 1952, outer-market sales in paper amounted to 12% of all bottled milk sold in the North Central Region and 35% of all the

FIG. 2. In the long distance marketing of milk the packages are usually reloaded from semi-trailers to smaller trucks for local distribution.

milk in the region put up in paper cartons. Outer-market selling has grown with the increase in the amount of milk sold in paper containers. Milk in paper cartons weighs about a third less than milk in glass, and it takes less space. Besides, milk is easier to keep cool in paper than in glass, and there is no problem of bottle return, which would be complicated in outer-market selling.

Although a few plants sold milk outside their local markets in paper cartons before World War II, 91% of the plants in the study started outside sales in paper since 1945, and 57% started in the period 1948-1950.

Extent of outside markets varies widely from plant to plant and in different parts of the region. One plant sold milk as far as 450 miles distant; another, no more than 10 miles. Nearly a fourth — 23% — sold milk more than 100 miles away, and 56% sold farther than 50 miles away.

The growth of outer-market selling has affected plants in different ways. Many plants that have developed outside sales have increased their volume. Some with too little volume to operate at low cost have been forced out of business. Some operators who have stopped bottling, and some who still bottle, are dis-

FIG. 3. Good highways are essential for long distance marketing of bottled milk.

[1] The complete report of this study is available from state colleges in the participating states — Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

[2] Federal-State Cooperative Agent with the North Central Regional Dairy Marketing Research Project. Department of Agricultural Economics, University of Illinois, Urbana.

tributing milk in paper cartons that is packaged in outside plants.

Methods of handling milk in the outer market vary widely. The bottling plant itself distributes about 60% of the milk sold in outer markets, but only a small per cent goes directly to the consumer from the main plant. Most is sold either on wholesale routes or through branch distribution points or other company plants.

Approximately 40% of the outer-market milk is sold outright to other distributors but only 9% is packaged under the distributor's brand. The other 31% is sold to distributors who handle milk bearing the packager's brand name. A little more than half of this is delivered by the packager to local dealers, known also as jobbers. The rest is handled by vendors who pick up their milk at the plant.

Other conclusions drawn from the study are:

1. Outer-market distribution areas extend farther in thinly populated regions than in more heavily populated ones.

2. Plants in small towns sell a greater proportion of their milk in the outer-market than do plants in large cities.

3. Outer markets of plants in different places overlap, especially in the more heavily populated sections.

The trend toward outer-market selling is likely to continue. Expansion will be slower and perhaps more orderly from now on. Apparently there was some slowing down after the 1948-1950 period of rapid development. Further expansion is anticipated because the development of outer-market sales is one phase in the long-time trend toward fewer and larger plants.

Although this type of distribution has gone along with expanding use of single service containers, other factors have encouraged it. Modern highways, efficient trucks, and improvements in refrigeration have made it possible to distribute packaged milk over a wide area. At the same time plants have found it increasingly important to have large volume if they are to operate at a low per-unit cost. One way to increase volume is to expand market area.

Another reason for the expansion of market areas has been consumer demand for pasteurized and inspected milk. Some towns have adopted ordinances requiring such milk. When small local plants were unable to meet these standards, outside milk came in. Even in markets where pasteurized and inspected milk was not required, milk meeting these specifications was brought in from the outside because of consumer demand. In some areas of the region, it is not unusual to find towns of several thousand depending almost entirely on outside sources for bottled milk.

New or expanding plants will have to take outer-market possibilities into consideration when locating new plants. Smaller plants are almost sure to face competition from the larger outside plants, especially in the case of store business. Some of the smaller plants that continue to process milk may find it best to drop their wholesale routes and specialize in retail distribution.

There are some obstacles to the expansion of outer-market sales of milk. For example, in certain places health ordinances prohibit bringing in milk that is pasteurized outside the town or more than a few miles distant. There is some indication, however, that restrictions of this type are gradually breaking down.

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# JOURNAL OF DAIRY SCIENCE

# ABSTRACTS OF LITERATURE

W. O. Nelson, Abstract Editor

## BOOK REVIEWS

**340. Manual of Infertility and Artificial Insemination of Cattle.** P. G. MILLAR and N. P. RAS. Alexander Eger, Inc., Chicago, Ill. 339 pp. $5.00. 1952.

The first section of the book is devoted to the anatomy and physiology of reproduction in the cow and the bull, to the clinical examination of animals and to methods of evaluating semen. In the second and third sections various aspects of infertility and factors affecting fertility in both sexes are considered. The last section, the shortest of the four, is devoted to artificial insemination.

The authors have done an excellent job of presenting information dealing with reproduction and certain problems of fertility in cattle. Their coverage of the role of infective disorders and anatomical abnormalities, and the clinical diagnosis and treatment in cases of infertility is especially to be commended. They might be criticized on the other hand, for refusing to discuss normal fertility on the grounds that there is no such standard. Further, their treatment of the subjects dealing with environmental factors affecting fertility is weak in that little is included on the effects of season, light, nutrition and management on fertility. The section of the book on artificial insemination is not as comprehensive as one might be led to believe from the title of the book.

The book should be valuable not only to the veterinarian, but also to all those who are dealing everyday with fertility problems in cattle.

N. L. VanDemark

**341. Air Conditioning Refrigerating Data Book. Design Volume, Eighth Edition.** AMERICAN SOCIETY OF REFRIGERATION ENGINEERS. 1953.

This book is the latest of a continuous series of Data Books. It covers fundamentals such as theory, principles, and basic engineering information used in the design of refrigerating equipment and refrigerating and air conditioning systems. The contents of the book are presented in eight sections comprising forty-one chapters. In addition to the index and some ASRE information there are 224 pages of classified advertising in the refrigeration field.

The sections are: I. Theory; II. Physical Data; III. Application Design; IV. Basic Equipment; V. Auxiliaries and Self-contained Units; VI. Operation; VII. Tables; VIII. Miscellaneous.

New chapters have been added on The Heat Pump, Absorption and Steam Jet Units, and Abbreviations and Symbols. Some chapters have been rewritten completely, while some are combinations and revisions of chapters in the previous edition. The former chapter on Commercial Refrigerators was omitted since this material appears in the Applications Volume, the alternate year publication of the ASRE.

L. M. Dorsey

**342. Pumps.** FRANK A. KRISTAL and F. A. ANNETT. McGraw-Hill Book Company, Inc., New York. 1954.

The second edition of this book first published in 1940. A comprehensive presentation of types of pumps and their applications. Problems arising in the use of pumps are covered in a practical manner. The entire field of industrial uses are found such as food products, boiler feed, sewage and sludge, and chemical. One Chapter (10) is devoted to sanitary pumps. Some other chapters are of particular interest to users of pumps in the dairy industry — Chapter 12, Methods of Priming Pumps — Chapter 13, What Is Head on a Pump? — Chapter 14, Economical Size for Pumps — Chapter 15, Pump Operation — Chapter 16, Pump Selection, Installation, and Operation — Chapter 17, Centrifugal-Pump Troubles and Remedies. The volume is profusely illustrated.

L. M. Dorsey

## BUTTER

**343. Increasing repeat sales of butter.** L. J. WILL, Gen. Mgr., American Dairy Association, Chicago. Milk Prod. J., 45, 2: 31. 1954.

Butter deserves and is getting increasing sales support. The ADA research has helped in highlighting the differences in nutritional qualities between butterfat and other fats and oils.

The ADA is helping to find new uses for butter through fact-finding market research. In the past the primary use for butter has

been as a spread. The present advertising trend is to support the use of butter for cake frostings, sauces and the like. Advertising in the form of special butter days, butter rallies, and colorful labeling has shown surprisingly good results. A well-balanced program of research, merchandising, advertising and public relations is the key to the present ADA program. J. J. Janzen

**344. Hard butter composition.** G. BARNSKY and G. ZINZALIAN (assignors to E. F. Drew & Co., Inc.). U. S. Patent 2,667,418. 6 claims. Jan. 26, 1954. Official Gaz. U. S. Pat. Office, **678**, 4: 1051. 1954.

A mixture of neutral unhydrogenated glycerides containing the following percentages of fatty acids: capric and caprylic 1-2.5; lauric 44-57; myristic 16-23; palmitic 10-13; stearic 2-4; and oleic and linoleic 7-24.

R. Whitaker

**345. The characteristics of Argentine butter.** G. CERUTTI and P. L. FARFALETTI-CASALI, Stazione Sperimentale Freddo, Milan, Italy. Ann. speri. agrar. (Rome), **7**: 979. 1953. (Chem. Abstr., **48**: 1597g, 1954.) S. Patton

**346. Detection of margarine in butter.** J. PIEN, J. M. DÉSIRANT, and B. LEFÈBVRE. Ann. fals. et fraudes, **46**: 350. 1953. (Chem. Abstr., **48**: 1598b, 1954.) S. Patton

**347. Detection of fish fats in butter with the Bellier's resorcin method.** F. DE FRANCESCO. Boll. lab. chim. provinciali (Bologna), **3**: 16. 1952. (Chem. Abstr., **48**: 1706i, 1954.) S. Patton

**348. A new index for the butter analysis.** B. CADROBBI and F. DE FRANCESCO. Boll. lab. chim. provinciali (Bologna), **3**: 7. 1952. (Chem. Abstr., **48**: 899i, 1954.) S. Patton

**349. The role of surface phenomena in the butter-formation process.** A. BELOUSOV. Molochnaya Prom., **14**, 9: 28. 1953. (Chem. Abstr., **48**: 900b, 1954.) S. Patton

**350. A system of investigation to detect the adulteration of butter by margarine.** P. C. DEN HERDER. VIII° Congr. intern. inds. agr. Brussels, **4**: 68. 1950. (Chem. Abstr., **48**: 901c, 1954.) S. Patton

**351. Quality and keeping quality of non-washed butter.** F. H. MCDOWALL, J. A. SINGLETON, and J. J. O'DEA. The Dairy Research Institute, Palmerston North, New Zealand. New Zealand J. Science & Technol., **35A**, 3: 175. 1953.

Studies in pilot plant and six commercial plants showed butter to be of equivalent grade when washed and unwashed. Losses in storage were similar as determined by several quality tests including bacterial count. Although washing does add to cost of production, it is often necessary for control of firmness of butter.

G. E. Stoddard

## CHEESE

**352. Cottage cheese with raisins.** R. BINDER and W. V. CRUESS, Food Technol. Dept., Univ. of Cal., Berkeley. Milk Dealer, **43**, 3: 43. 1953.

Cottage cheese with added fruit has been placed on the market by several producers. It is recommended that raisins be used for experimental trial by cottage cheese producers. In experimental work, Thompson seedless raisins were used. The moisture content of the raisins was varied from about 16 to about 50%. Those containing about 50% proved best. If the moisture content is too low, the raisins withdraw moisture from the cottage cheese causing it to have a dried-out appearance and texture. Raisins of about 15% moisture were heated to boiling in enough water to bring their moisture content to about 50%; and allowed to stand until most of the water was absorbed. The raisins and the unabsorbed juice were added to cottage cheese and mixed in thoroughly. The cottage cheese was of the cream type containing about 74% moisture. The use of raisins with more than 50% moisture resulted in a cheese that was too wet and thin in consistency. The preferred ratio was 20 lb. of raisins to 80 lb. of cottage cheese. C. J. Babcock

**353. They took the "plod" out of fresh-cheese making.** A. V. GEMMILL, Senior Assoc. Ed., Food Eng. **25**, 12: 78. 1953.

Modernized procedures in making and packaging Mozzarella cheese have been adopted by Aiello Dairy Farms Co., Brooklyn, N. Y. The elimination of some hand operations has reduced labor and increased sanitation in the manufacture of this Italian-type cheese. Initial steps of setting, cooking, and draining are carried out in the country plant. The curd is transported in iced bags to the Brooklyn plant for further processing and packaging. After shredding, the curd is kneaded and stretched in a specially equipped dough mixer. The cheese is transferred to clean, hot water for further conditioning. It is then divided into small rectangular, consumer-size portions, and placed in a brine tank for salting. The portions are finally packaged automatically in cellophane for distribution. T. J. Claydon

**354. Sanitary aspects of quality cheese production.** J. C. MARQUARDT, N. Y. State Dept. of Agr. and Markets, Geneva. Am. Dairy Prod. Rev., **15**, 12: 4. 1953.

The article relates chiefly to the problem of surface slime in cottage cheese. The defect was partially controlled by the addition of 2%

starter to creaming mixtures before pasteurization. Further study was made on 21 vats at 4 plants. The addition of 7.5 p.p.m. of available active iodine to the final wash water retarded the development of water-borne organisms causing the slimy condition. A keeping quality test to detect the development of the defect involved 2 d. storage at 50° F. followed by holding at 75-80° F. Cheese showing no surface growth after 5 d. at the latter temperature was considered satisfactory. In the examination of 32 samples there was no correlation between the score of the cheese when fresh and the rate of spoilage; 12 samples showed satisfactory keeping quality. Samples made with acidulated creaming mixtures or iodine treated wash water held up best. T. J. Claydon

**355. Sanitary aspects of quality cottage cheese production.** J. C. MARQUARDT, N. Y. State Dept. of Agr. and Markets, Geneva, N. Y. Milk Dealer, **43**, 4: 82. 1954.

A study of 21 vats of curd and creamed curd cottage cheese at 4 plants demonstrated that 7.5 p.p.m. of available active iodine when added to the final wash water inhibited or retarded the growth of organisms commonly found in water supplies which caused the slimy surface on cheese. Two washings instead of three could be used when the final water was treated. In the study, 32 samples of cottage cheese were held at 50° F. for 2 d. and then transferred to 70 to 80° F. At this temperature, 11 samples developed slime, mold or both in two d. Five showed this spoilage in three d., four samples spoiled in four days. The other samples were free of surface growth after 5 d. There was no correlation between the score of the cheese when fresh and the rate of spoilage. Samples made with acidulated creaming mixtures or iodine treated wash water held up best. In two cases where both practices were employed, the cheese kept very well. C. J. Babcock

**356. Examination of cream and cottage cheese for the pasteurization (temperature) of the starting material.** M. SHILOVICH and O. KORNILOVA. Molochnaya Prom., 14, **9**: 34. 1953. (Chem. Abstr., **48**: 899f, 1954.) S. Patton

**357. Vegetable milk. I. Processing and nutritive value.** D. K. NANDI, R. RAJAGOPALAN, and S. S. DE, Indian Inst. Sci., Bangalore. Indian J. Physiol. and Allied Sci., **7**: 1. 1953. (Chem. Abstr., **48**: 904e, 1954.) S. Patton

**358. Modification of the Van Gulik method for the determination of fat in soft cheese.** A. PINSKY and A. GRÜNPETER, Agr. Research Sta., Rehovoth, Israel. Analyst, **78**: 621. 1953. (Chem. Abstr., **48**: 900d, 1954.) S. Patton

**359. Copper and Cheddar flavor.** J. B. STINE, H. LOOS, and H. E. DAUME, Kraft Foods Co., Glenview, Ill. Dairy World, **32**, 3: 10. 1953. (Chem. Abstr., **48**: 900e, 1954.) S. Patton

**360. The vitamin $B_2$ content of cheeses.** A. MONZINI and A. ARTOM, Sta. sper. Freddo, Milan. VIII. Congr. intern. inds. agr. Brussels, **4**: 83. 1950. (Chem. Abstr., **48**: 1598d, 1954.) S. Patton

## CONDENSED AND DRIED MILKS; BY-PRODUCTS

**361. Frozen concentrated milk products.** E. G. STIMPSON (assignor to National Dairy Research Laboratories, Inc.). U. S. Patent 2,668,765. 13 claims. Feb. 9, 1954. Official Gaz. U. S. Pat. Office, **679**, 2: 445. 1954.

Age thickening of frozen concentrated milk is delayed by treating a portion of the product with lactase to hydrolyze the lactose into simpler sugars. R. Whitaker

**362. Cultured and fermented milks.** G. MOREY. Brook Hill Farms, Inc. Chicago, Ill. Milk Dealer, **43**, 4: 65. 1954.

The results of a quality survey on 51 samples of commercial buttermilks indicate that there is too much variation in the quality, and that much of the buttermilk in the market could be improved considerably by the use of more butterfat. C. J. Babcock

## DAIRY BACTERIOLOGY

**363. Routine coliform and standard plate counts.** J. L. COURTNEY, Director, Public Health Laboratory, Oak Ridge, Tenn. Milk Plant Monthly, **42**, 12: 39. 1953.

A survey, based on a year's study, shows the general tendency for high plate counts to be accompanied by high coliform counts. Standard plate counts are tabulated for milk, cream, frozen desserts and chocolate beverages. Using approximate percentages, 81% of the milk, 88% of the chocolate beverage, 67% of the frozen desserts, and 60% of the cream samples complied with standards of not more than 30,000 per ml. for milk and chocolate beverage, not more than 60,000 per ml. for cream, and not more than 50,000 per ml. for frozen desserts. Coliform counts showed that 85% of the milk, 77% of the chocolate beverage, 45% of the frozen desserts and 44% of the cream samples complied with the standard of not more than 10 coliforms per ml. C. J. Babcock

## DAIRY CHEMISTRY

**364. Milk proteins. Effect of heat treatment on serum proteins.** R. JENNESS, Dept. of Agr. Biochem., Univ. of Minn., St. Paul. J. Agr. Food Chem., **2**, 75. 1954.

The effects of heat on the proteins of milk serum are of importance in relation to cooked flavor, antioxygenic properties, and impairment

of coagulation of the casein. The milk serum proteins are denatured by heat treatments in the range 60 to 80° C. for times up to 2 hours. Two important manifestations of denaturation are decreased solubility in acid and salt solutions and increased activity of sulfhydryl groups, the latter largely confined to the β-lactoglobulin fraction. Individual lots of mixed milk differ in content of serum proteins and in the response of these proteins to heat treatment; precipitation tests are consequently not precise indexes of the heat treatment a sample has received. Many of the sulfhydryl groups of β-lactoglobulin are activated by heat treatment to such an extent that they are oxidizable by atmospheric oxygen. Denaturation of β-lactoglobulin as measured by sulfhydryl activity follows first-order kinetics and has an activation energy of about 80,000 calories per mole. The activation of sulfhydryls parallels the decrease in solubility. The activated –SH groups may function as antioxidants in dairy products. The deleterious action of unheated milk on the consistency of wheat flour doughs and on the loaf volume of bread is not associated with sulfhydryl groups, as was formerly postulated. S. Patton

**365. Volumetric determination of chlorides in milk.** C. R. Cano Marotta, Fac. Quim. farm., Montevideo. Anales asoc. quím. y farm. Uruguay, **52**: 1. 1952. (Chem. Abstr., **48**: 1596h, 1954.) S. Patton

**366. Proteins of whey. I. Fractionation by salting out and electrophoresis.** U. Freimuth, Deutsche Akad. Landwirtschaftswissenschaften, Berlin. Biochem. Z., **324**: 476. 1953. (Chem. Abstr., **48**: 1597a, 1954.) S. Patton

**367. The detection of substitute fats in dairy products.** L. R. Bryant and D. A. Biggs. Can. Dairy Ice Cream J., **22**, 9: 27. 1953.

There are at present no simple tests for the detection of substitute fats in dairy products. Lawerence's fluorescence test is valid only when the butterfat has been completely replaced by vegetable fats. Total substitution by vegetable fats may be completely masked by the addition of small amounts of carotene. The critical temperature of dissolution test will readily detect total substitution with vegetable fats and possibly partial substitution down to about 50%. It is possible to blend vegetable fats to give a C. T. D. test within the normal butterfat range. Study of the possibility of using a tracer chemical to identify edible fats other than milk fat revealed that butylated hydroxyanisole (B. H. A.), an antioxidant, could be used for this purpose. Edible fats containing 0.02% B. H. A. can be quickly detected in dairy products when as little as 10% of substitute fat, based on the total fat content of the product, is present. H. Pyenson

**368. Fat rancidity. Recent studies on the mechanism of fat oxidation in its relation to rancidity.** S. G. Morris, Eastern Regional Research Lab., Philadelphia 18, Pa. J. Agr. Food Chem., **2**, 126. 1954.

The autoxidation mechanism, as now generally accepted, is a chain reaction involving radicals formed at the α-methylene groups adjacent to the double bonds. The radicals consume oxygen and then react with another olefin to give hydroperoxide and another free radical. Each free radical is a resonance hybrid compound of three equivalent structures. The displacement of double bonds occurring in oxidation can be accounted for by this free radical mechanism. By the use of new or improved techniques, evidence has been attained to support the fundamental concepts. Chromatography and counter-current distribution methods have been applied to the isolation and identification of oxidation products. Polarographic methods have been developed for the determination of hydroperoxides, and in the presence of oxidation decomposition products may be more specific than the chemical method. Ultraviolet spectrophotometric analyses have aided in the identification of oxidation products and in revealing double bond shifts which take place in polyunsaturated fatty acids. Infrared spectrophotometry was useful in determining changes in geometrical configuration of fatty materials and in detecting functional groups. Data obtained by these techniques by numerous workers are discussed in relation to the mechanism of oxidation of mono-, di-, and triethenoic fatty acids. S. Patton

## DAIRY ENGINEERING

**369. Trends in European dairy plant equipment.** O. Wolfrum, Vienna, Austria. Milk Prod. J., **45**, 2: 34. 1954.

The author discusses some of the recent trends in European dairy plant equipment. The most revolutionary development has taken place in the sphere of buttermaking, resulting from the invention of the continuous buttermaking process and the introduction of the stainless steel churn. Of the two continuous buttermaking processes, Fritz and Alfa, the Fritz system is the more popular in Europe. Newer designs in the sphere of cream ripening have replaced the older, more cumbersome methods.

In the sphere of cheesemaking, manual work has been replaced in large measure by the so-called cheese worker. The cheese workers consist of a cylindrical container of aluminum or stainless steel, surrounded by a second wall in order to heat the contents by means of warm water. By means of an agitator that can be equipped with various cutting devices, the curd is cut and worked. A filling device is furnished with the unit which permits swift distribution into hoops. These have proved satisfactory for

Tilsit, Edam, Gouda and most other kinds of cheese.

The old systems of refrigeration consisting of $CO_2$ and ammonia compressors utilizing brine cooling have been replaced in large measure by methylchlorine and freon compressors for small capacities, while ammonia compressors are still used for the bigger capacities. Some ice storage as a means of refrigeration for fluid milk cooling is also used.

J. J. Janzen

**370. Knockdown sampling dipper for ladling dairy products.** H. S. SPENCER. U. S. Patent 2,668,448. 3 claims. Feb. 9, 1954. Official Gaz. U. S. Pat. Office, **679**, 2: 351. 1954.

A sampling dipper consisting of a dipper bowl equipped with a valved outlet through which the sample can be released, and a detachable rigid handle. All parts can be easily disassembled for cleaning. R. Whitaker

**371. Bottle capping machine.** H. G. VORE and A. C. MAGALOS (assignors to American Seal-Kap Corp.). U. S. Patent 2,667,999. 7 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 148. 1954.

Details are given for constructing a capper which closes milk bottles with a pleated thermosetting hood cap. R. Whitaker

**372. Mouthpiece for cap magazines.** F. C. RODMAN (assignor to American Seal-Kap Corp.). U. S. Patent 2,668,000. 3 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 148. 1954.

A device for feeding to a milk bottle closing unit one cap at a time from a magazine of nested bottle caps. R. Whitaker

**373. Continuous milk filling system.** W. H. HARSTICK (assignor to International Harvester Co.). U. S. Patent 2,668,001. 6 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 148. 1954.

A device for attaching to the lid of a milk can, of a type which makes an airtight closure and so designed that the can, one of a series, is filled with milk from a vacuum milker to a predetermined level. When the desired level is reached, the milk flows to the next can in the series. R. Whitaker

**374. Centrifugal separator for cold milk products and the like.** H. M. SPROSS (assignor to De Laval Separator Co.). U. S. Patent 2,668,008. 3 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 150. 1954.

The bowl of an airtight separator for skimming cold milk is described in detail.

R. Whitaker

**375. Bottle capping machine control mechanism.** H. W. MARTIN (assignor to American Seal-Kap Corp.). U. S. Patent 2,668,203. 3 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 198. 1954.

An apparatus for operating a switch when milk bottles are positioned for capping on a closing machine. R. Whitaker

**376. Milk bottle crate.** E. G. HOCH. U. S. Patent 2,667,284. 2 claims. Jan. 26, 1954. Official Gaz. U. S. Pat. Office, **678**, 4: 1014. 1954.

A milk bottle crate for either square or round bottles. The dividing partitions are so formed that when the square bottles are inserted, the bottles are automatically twisted by a cam and guided into the compartments.

R. Whitaker

**377. Apparatus for treating liquids.** A. H. BOILEAU, C. J. RAYMAN, and F. S. BOARD (assignors to Cherry-Burrell Corp.). U. S. Patent 2,665,628. 3 claims. Jan. 12, 1954. Official Gaz. U. S. Pat. Office, **678**, 2: 420. 1954.

A safety device is described for instantly preventing milk, cream, etc. from entering the processing chamber of a vacuum pasteurizer, should the vacuum supply fail.

R. Whitaker

## DAIRY PLANT MANAGEMENT AND ECONOMICS

**378. Selling more at lower costs.** R. W. BARTLETT, Coll. of Agr., Univ. of Ill., Urbana. Milk Plant Monthly, **42**, 12: 19. 1953.

The greater opportunity for lowering distribution costs, lowering retail prices, and increasing per capita sales of milk is to initiate mass distribution of milk with a store differential ranging from two to six cents a qt. in all the markets that now have a one-cent or no differential, as well as to keep cutting away at gross distribution margins of markets where store sales are already large. Lower distribution costs are being brought about by the gallon jug, half-gallon containers, intermarket shipments and the use of fresh concentrated milk. Research that should be initiated to broaden the outlets for milk and its products is discussed.

C. J. Babcock

**379. Mobile light truck refrigeration system is simple and foolproof.** ANON. Refrigerating Engineering, **62**, 2: 39. 1954.

The General Electric Company's Specialty Component Motor Department announces a new electrical system which makes possible around-the-clock, full capacity, high voltage refrigeration for light delivery trucks. It is designed to operate at full capacity off the truck crankshaft whether the engine is idling or running at maximum road speed. At plant it can utilize standard 115-volt 60 cycle current when the engine is not running. Battery power not required at any time. The take-off drive operates an alternator rectifying through a

selenium rectifier to operate 90 volt DC motors for compressor and fan of the refrigerating unit. The plant AC is rectified to DC. A prototype truck has been in operation since last spring as a milk delivery truck and has maintained temperatures in the range of 40 to 45° F. under the adverse conditions of hot summer days. L. M. Dorsey

**380. Bringing the Elwell plan up to date.** E. S. ELWELL, Northland Milk and Ice Cream Co., Minneapolis, Minn. Milk Dealer, **43**, 3: 48. 1953.

The original Elwell plan showed that, if a profit was made on the first qt. of milk sold, additional units on the same delivery could be sold at 4¢ less than the price of the first unit. Delivery costs have now risen to a point where additional units can be sold for at least 10¢ less. The actual cost difference is about 12¢, but 10¢ makes an excellent discount figure. The gallon jug and the 2 qt. bottle have come into the markets, and in many places at greatly reduced prices because we did not give the larger consumer the price they earned. The present price in Minneapolis is 21¢ for the first qt. and 19¢ for additional qts. In this market, a more realistic pricing system would be 26¢ for the first qt. and 16¢ for each additional qt. One of the objections the milk dealer had to this plan was that it would be difficult to check. A commission plan whereby the driver would receive the whole service charge of 10¢ and a percentage on collections would largely cure the checking problem. It can be demonstrated that drivers, customers, and dealers would benefit under this plan. This system would act as an equalizer and compensate the driver who serves many small customers. It more nearly pays the driver for the number of stops served rather than for just the amount of products sold. We should keep our quality high and give the buyers the service they are willing to pay for. If they want little milk and lots of service, let them pay for it. If they buy lots of milk and little more service than the small user, give them the price they earn. C. J. Babcock

**381. Trucks converted to liquefied petroleum gas.** W. J. THOMPSON, Carnation Co., Los Angeles, Cal. Ice Cream Rev., **37**, 6: 50. 1954.

Fifteen years experience with liquefied petroleum gas as a fuel for trucks has indicated that its use is practical and economical for fleet operations. The chief advantages of this fuel over gasoline are discussed in detail. The changes necessary for conversion to use of liquefied petroleum gas are outlined. If handled according to approved safety regulations the use of liquefied petroleum fuel is no more hazardous than gasoline. W. J. Caulfield

**382. A current look at supermarket merchandising.** D. J. COOK, National Dairy Products Corp., New York, N. Y. Ice Cream Trade J., **50**, 1: 32. 1954.

Ice cream sales in food stores have accelerated tremendously since 1938. Supermarkets with an annual business of 6,000 gal. do 10 times the business the average grocery outlet did in 1951. When the average of all stores was 625 gal., the turn-over rate of 50-60 times a year is several times greater than for other food store items. Available estimates indicate that supermarkets do 44% of the grocery business and 50% of the food store ice cream business. Because of the importance of ice cream sales in the food supermarkets, there is a need for a mutual understanding between the ice cream manufacturer and the store operator. Stores should devote more time to merchandising ice cream and plants should do more to develop brand consciousness, acceptance and loyalty. W. H. Martin

**383. Mildew problems eliminated by new type of paint.** F. JOHNSON. Can. Dairy Ice Cream J., **33**, 1: 36. 1954.

A new paint is described that completely eliminates mildew in food processing industries. The name of the paint is not given. The new paint embodies all the properties desirable for a paint in dairies where mildew is a problem. It is made up of microscopic particles of flexible rubbery plastic dispensed in water. The paint is not attacked by alkali, is non-toxic to humans, does not fade, does not get brittle with age, has good adhesion properties, has very little odor and is easy to apply. H. Pyenson

**384. Dairy paints and coatings and methods of application.** D. A. SEIBERLING, Dept. of Dairy Tech., Ohio State Univ., Columbus. Ice Cream Trade J., **50**, 1: 46. 1954.

Three types of coating for dairy plant equipment were obtained from 8 paint manufacturers and subjected to various destructive conditions.

As determined by accelerated testing procedures, the vinyl plastic coatings appeared to be most resistant to destructive conditions prevalent in dairy plants. Rubber base enamels varied appreciably in durability; one sample approached the vinyls, but others were inferior and approached the durability of the equipment's enamels which were the least rugged of the three groups. Surface preparation and priming treatments were shown to affect durability of top coatings. There was no advantage for brush or spray applications insofar as durability was concerned, but physical characteristics of coatings and existing conditions in painting areas may affect the choice of application method. W. H. Martin

**385. Why make two when one will do?** ANON. Ice Cream Rev., **37**, 6: 48. 1954.

A 6,000-gal. capacity aluminum trailer for transporting ice cream from the Borden Com-

pany's Hutchinson Ice Cream Division at Cedar Rapids, Iowa to branches located within a 135-mile radius was put into service in May, 1953. The new trailer tandem permits a pay load of 30,000 lb. The trailer is insulated with styrafoam and is refrigerated with seven ammonia plates. The trailer is cooled to –18 to –20° F. before loading and maintains the temperature under all weather conditions. Defrosting is accomplished on the return trip when front and rear defrosting doors are opened to provide air circulation. Moisture is removed through a floor drain at the rear of the trailer.

The use of this new light-weight aluminum trailer with its greater pay load has made it possible to service two branches with one trip, whereas formerly only enough ice cream could be carried for a single branch per trip. This has markedly reduced mileage and time necessary in servicing the distribution branches of the company. The operating cost for the trailer including depreciation has averaged 12.6 cents per mile. W. J. Caulfield

**386. Palletized loading.** T. KNIGHT. Milk Plant Monthly, **43**, 1: 32. 1954.

The Supplee-Wills-Jones Company, Philadelphia, is using conveyors, pallets, and fork-lift trucks for loading and unloading all delivery vehicles and for materials handled within the plant. This has resulted in a reduction of 75% in truck loading and unloading labor, and has practically eliminated breakage and the accompanying product loss. C. J. Babcock

**387. Outlook for future supplies of paper milk containers.** ANON. Milk Dealer, **43**, 4: 56. 1954.

The two chief raw materials used in the production of paper milk containers are 100% bleached sulphate paper and paraffin. The latter is not a problem as far as future supply is concerned, even though over 150,000 tons are currently required each year. Major oil companies produce paraffin in quantity as a by-product of the oil industry and their facilities assure a continuous future supply. Somewhere between 300,000 and 400,000 tons of 100% bleached sulphate paper are now used annually. This could become a problem but the manufacturers of paper milk containers have taken effective steps to assure an adequate, continuous supply of pulp wood and paper board suitable for the production of paper milk containers. The steps taken to assure this supply are discussed and the manufacturing process of sulphate paper described. C. J. Babcock

**388. Future trends in the dairy industry.** R. W. BARTLETT, Univ. of Ill. Milk Dealer, **43**, 4: 124. 1954.

There are indications that per capita sales of butter, ice cream and evaporated milk are likely to decrease, while per capita sales of market milk, cheese and dried whole milk will increase. With these changes, we shall probably also have a net increase of 11.4% in population by 1960. The combined effect of changes in population and per capita sales is likely to result in an increase of around 9% in total milk needed in 1960 compared with the amount used in 1950.

It is predicted that per capita sales of market milk and cream will be 20% higher in 1960 than in 1950. This is predicated on the following assumptions: (1) that efficient distribution practices now in use on a limited scale will be adopted generally, with the result that prices to consumers on a nationwide basis will be reduced as much as 2 or 3 cents a quart, (2) that competitive Class I (Market milk) prices will be restored in specific areas of the country that now exact prices above their competitive level, (3) that a battery of vending machines, some dispensing half pints or third quarts and others dispensing quarts or two quarts of milk, will be distributed in strategic locations throughout the country to make milk more available, (4) that vendors who own their own trucks and buy bottled milk at the platform will gradually replace union drivers in all areas where wage rates exacted are materially above their competitive level, (5) that fresh concentrated milk from surplus producing areas will be sold in all areas of the country where present consumer prices for whole milk are materially above the nation's average, and (6) that research studies will show other ways of broadening the market for milk and its products. Some of the favorable and unfavorable things that have taken place in the dairy industry also are discussed. C. J. Babcock

**389. The milk can's future — and its relation to quality.** V. SCHWARZKOPF, Lathrop-Paulson Co., Chicago. Milk Prod. J., **45**, 2: 28. 1954.

The milk can is still the most satisfactory means for handling milk in the average milk shed. It is economical, it requires minimum capital investment, accurate weights and representative samples for butterfat test are readily obtainable, and mechanical losses can be held to insignificant levels. It also fits the requirements for producing milk of high quality on the average farm.

The control of the quality of the milk is simplified and made more positive in that each individual can may be checked for quality by qualified personnel. The rejection of a can of milk in itself becomes a powerful factor in maintaining a milk supply of high quality.

Since the milk can has proved itself to be so versatile for handling milk and its products, it will, in the author's opinion, continue to be used for many more years. J. J. Janzen

**390. Specifications and costs for a milk pasteurizing and bottling plant.** M. C. CONNER,

L. SPENCER, and C. W. PIERCE, Va. Polytech. Inst., Blacksburg. Bull. 463. After 1952.

A mythical plant was constructed with specifications as to labor, building, equipment, and other facilities. This plant had a daily capacity of 15,000 qt. at full utilization and processed 13 different products and package sizes. On the basis of these specifications, the plant required 4,500 sq. ft., equipment valued at $100,000 and a crew of 9 men. Total daily operation costs amounted to $339.62. Of this amount, plant costs accounted for $204.56, package costs $120.64, and shrinkage $14.42. Wages amounted to 60% of plant costs. Because of the high percentage of fixed costs for certain processing functions, changes in the quantities of products processed had a striking effect upon unit costs. For example, at an output of 400 qt. of light cream, the cost per qt. for the cream separating and processing was found to be 2.2¢, but when only 100 qt. were processed, the cost was 8.6¢. When plant production was reduced to 6,840 qt., the average plant cost per package increased from 1.18¢ to 2.06¢. Packaging costs of a split paper and glass operation increased $38.46 a day. The change required only 30 min. additional work, but another man had to be hired to watch the paper operation. The results of this work seemed to indicate that this type of budgetary procedure can be used to analyze costs and assist plants in developing more efficient operations. R. W. Hunt

**391. Milk distribution and pricing in Great Britain.** L. SPENCER and S. JOHNSON, Cornell Univ. Agr. Expt. Sta., Ithaca, N. Y. Bull. 902. 1953.

This very extensive bull. discusses the production and utilization of milk, distribution methods and agencies, consumption of and demand for milk, pricing of milk to producers, dealers and consumers, unified system of collecting milk from farms, zoning of milk distribution in cities, and includes a well prepared bibliography. The purpose of this bull. is to gain the experience from another country's system of milk distribution and pricing. R. W. Hunt

**392. Food delivery box.** M. CURCIO. U. S. Patent 2,669,385. 2 claims. Feb. 16, 1954. Official Gaz. U. S. Pat Office, **679**, 3: 673. 1954.

A box mounted in the wall of a house, for holding bottles of milk. The bottles are inserted through a trap door from the outside and removed through the open top of the box inside the house. R. Whitaker

## FEEDS AND FEEDING

**393. Dairymen use clover to cut production costs.** A. C. MAGEE, Texas Agr. Expt. Sta., College Station. Prog. Rpt. 1593. 1953.

During 1953 a group of Central Texas dairy farmers who grazed oats-clover that was planted after clover, enjoyed several advantages over dairymen whose oats-clover grazing followed Sudan grass, grain sorghum corn or other nonlegume crops. These advantages included: twice the grazing per acre of oats-clover, a saving of 240 lb. of concentrates and 300 lb. of hay per cow while oats-clover was being grazed, feed cost saving up to $15 per cow or $300 per farm, and a saving of 80¢ per cwt. R. W. Hunt

**394. Relationships between grazing behavior of dairy cows, forage digestibility and intake and milk production.** M. E. MCCULLOUGH, O. E. SELL, and W. E. NEVILLE, JR., Ga. Agr. Expt. Sta., Athens. Mimeo Series 71. 1954.

Data for 188 cow-days of grazing behavior, obtained during a two-year study of six pasture forages are presented in detail.

The total time spent grazing was chiefly affected by forage quantity and quality. A definite forage species effect was indicated as was a between-cow difference. Both high temperatures and forage conditions exerted an influence on the ratio of total grazing time which occurred during daytime versus night.

The total time spent ruminating was chiefly determined by the quantity and quality of forage consumed. The consistent negative correlations between dry matter intake and ruminating time indicated forage quality as the more important factor.

A combination of forage intake digestibility and grazing behavior studies may help explain variations in animal performance which would otherwise be impossible. Author Abstract

**395. Analytical studies on the carbohydrates of grasses and clovers. III. Carbohydrate breakdown during wilting and ensilage.** C. B. WYLAM, Univ. Edinburgh, Scot. J. Sci. Food Agr., **4**, 527. 1953. (Chem. Abstr., **48**: 1602a, 1954.) S. Patton

**396. Yucca leaves as fodder.** L. JUÁREZ G., La Molina, Peru. Agronomía (Peru), 18, **73**: 85. 1953. (Chem. Abstr., **48**: 1602f, 1954.) S. Patton

**397. Fermentation of glycerol in the rumen of sheep.** A. T. JOHNS, Dept. of Scientific and Industrial Research, Palmerston North, N. Z. New Zealand J. Science & Technol., **35A**, 3: 262. 1953.

Fermentation of glucose and glycerol *in vivo* and *in vitro* with microorganism from sheep rumen was carried out. Glucose was fermented immediately, whereas in 2¼ hours, glycerol was much more slowly fermented. *In vitro* fermentations were slower than *in vivo*.

Results indicate that glycerol may be effective in treating ketosis in ruminants because

(1) it is at least partially absorbed and (2) it is fermented slowly giving more prolonged treatment. G. E. Stoddard

**398. Mechanisms of cutaneous drug reactions, especially to antibiotics.** A. Rostenberg, Jr., and J. R. Webster, Univ. of Ill. Coll. of Med. and Northwestern Univ. Med. School, Chicago. J. Am. Med. Assoc., **154**, 3: 221. 1954.

Table of mechanisms by which cutaneous drug reactions may develop is presented for 15 different drugs. Implication of promiscuous use of antibiotics in allergically sensitizing a population to antibiotics is discussed. Difference between side reactions and allergy is emphasized in getting at source of reaction.
G. E. Stoddard

**399. Measurement of feed intake by grazing cattle and sheep. III. Marker technique for investigating the faeces output of grazing cows.** R. J. Lancaster, M. R. Coup, and J. C. Percival, Ruakura An. Research Sta., New Zealand Dept. of Agr., Hamilton, N. Z. New Zealand J. Science & Technol., **35A**, 2: 117. 1953.

Chromic oxide fed to cows was recovered from feces at rates of 102, 100 and 102 respectively for 3 cows. Collection started 5 days after start of daily dosing by capsule of 7.5 g. chromic oxide daily. Pooled a.m. and p.m. grab samples estimated quantitative fecal excretion with an error of about 10%. Afternoon grab samples tended to contain less chromic oxide than adjacent morning samples.
G. E. Stoddard

**400. Pressed vs. extracted linseed cakes for milk production by cows.** E. Letard, P. Szumowski, and H. Balbous. Bull. mens. inform. ITERG, 7: 429. 1953. (Chem. Abstr., **48**: 899c. 1954.) S. Patton

**401. Nutritive value of the carob employed in the feeding of animals.** B. Maymone and A. Battaglini. VIII$^e$ Congr. intern. inds. agr. Brussels, **4**: 220. 1950. (Chem. Abstr., **48**: 906d, 1954.) S. Patton

**402. Artificially dried grass and lucerne.** W. A. Pesch, Jr. Conserva (The Hague), **2**: 101. 1953. (Chem. Abstr., **48**: 906e, 1954.)
S. Patton

**403. Some new chemicals in preparing silages.** J. Martin and F. Buysse, Rijkssta. Veevoeding, Ghent, Belg. Mededel. Landbouwhogeschool en Opzoekingssta. Staat Gent, **17**: 616. 1952. (Chem. Abstr., **48**: 906g, 1954.)
S. Patton

**404. The vitamin content of raw food material (white hay, alfalfa, and red clover) from the point of view of the effect of the drying process on mineral uptake and weathering.** H. W. Scharpenseel, Bonn Univ. Ger. Archiv Tierernähr, **3**: 122. 1952. (Chem Abstr., **48**: 906h, 1954.) S. Patton

**405. Nutritional value of beet molasses.** S. Dalmeiren. VIII$^e$ Congr. intern. inds. agr. Brussels, **4**: 228. 1950. (Chem. Abstr., **48**: 907a, 1954.) S. Patton

**406. Production of edible oil and fodder for livestock from gourds.** Ivo Kranjc, Agr. Expt. Sta., Ljubljana, Yugoslavia. Kem. Zbornik, 80. 1951. (Chem. Abstr., **48**: 907a, 1954.)
S. Patton

**407. Albumin in our (Slovenia) fodder balance. II.** Joze Lavric. Nova Proizvodnja, **3**: 199. 1951. (Chem. Abstr., **48**: 907b, 1954.)
S. Patton

**408. Trimethylamine in fodders containing fish meal.** E. E. van Koetsveld, Inst. Moderne Veevoeding "De Schothorst," Hoogland, Netherlands. Conserva (The Hague), **2**, 44. 1953. (Chem. Abstr., **48**: 1602g, 1954.)
S. Patton

## GENETICS AND BREEDING

**409. Studies in monozygotic cattle twins. VII. The relative importance of inheritance and environment in the production of dairy cattle.** J. Hancock, Ruakura An. Research Sta., New Zealand Dept. of Agr., Hamilton, N. Z. New Zealand J. Science & Technol., **35A**, 2: 67. 1953.

Fifteen sets of identical twins were divided into 3 sets of 10 in an incomplete block design experiment to determine effects of three levels of nutrition on milk, butterfat and casein production. Heritability coefficients for milk yield .90, butterfat yield .86, casein yield .88, butterfat percentage .95 and casein percentage .94 were estimated. High coefficients were considered due mainly to strict environmental control. Selection on basis of heredity adaptation to an environment is discussed. Genetic correlations between milk, butterfat and casein yields are presented. G. E. Stoddard

**410. Studies in monozygotic cattle twins. VIII. Performance of identical twins when uniformly treated after having been subjected to different treatments in the previous lactation.** J. Hancock, Ruakura An. Research Sta., New Zealand Dept. of Agr., Hamilton, N. Z. New Zealand J. Science & Technol., **35A**, 2: 93. 1953.

Ten sets of identical twins were subjected, in the preceding lactation, to different nutritional levels which caused large differences in butterfat production and body weight. During the subsequent lactation when treated alike,

production over a 200-day period was not significantly different. Cows had been allowed to regain body weight during dry period.
G. E. Stoddard

**411. Studies in monozygotic cattle twins. IX. The value of identical twins in short-term trials.** J. Hancock, Ruakura An. Research Sta., New Zealand Dept. of Agr., Hamilton, N. Z. New Zealand J. Science & Technol., **35A**, 2: 97. 1953.

Meal feeding at the rate of 1 lb. per 100 lb. body weight increased milk and butterfat production over the 3 months following calving by 10 and 11 percent with little effect on body weight and butterfat percentage. Turnips fed as pasture supplement on an equal dry matter with corn silage, produced approximately 9% more milk and butterfat over an 8-week period than the silage fed group. The value of identical twins in such experiments is discussed.
G. E. Stoddard

**412. Studies in monozygotic cattle twins. X. General summary.** J. Hancock, Ruakura An. Research Sta., New Zealand Dept. of Agr., Hamilton, N. Z. New Zealand J. Science & Technol., **35A**, 3: 189. 1953.

Summarizes the preceding investigations on monozygotic cattle twins. G. E. Stoddard

## HERD MANAGEMENT

**413. Thornapple — poison for a farm pest.** R. R. Morrow, Cornell Univ. Agr. Expt. Sta., Ithaca, N. Y. Farm Research **XX**, 1: 12. 1954.

Preliminary experiments indicate that 1% sol. of the propylene glycol butyl ether esters of 2, 4, 5-T and 2, 4-D are both effective herbicides against thornapple. R. W. Hunt

**414. Cow barn gutter cleaner.** C. G. Holloway. U. S. Patent 2,667,264. 18 claims. Jan. 26, 1954. Official Gaz. U. S. Pat. Office, **678**, 4: 1008. 1954.

A rod or shaft parallel to the gutter is given a reciprocating motion. Paddles are hinged at intervals along the rod and swing across the gutter, moving the litter forward each time the rod is moved forward. R. Whitaker

**415. Vacuum regulating device for pipe-line milkers.** H. A. Heckendorf (assignor to International Harvester Co.). U. S. Patent 2,667,856. 12 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 106. 1954.

A device for controlling the vacuum on a series of milking machines and on closed milk cans into which the milk is delivered from the milkers. R. Whitaker

**416. Airtight milking machine.** W. A. Scott (assignor to The De Laval Separator Co.). U. S. Patent 2,667,855. 8 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 105. 1954.

By operating a system of valves, an inert gas under pressure can be admitted to the milk reservoir of a vacuum type milking machine, thus forcing the milk from the reservoir into a conduit for delivery into a large milk storage tank without the milk coming in contact with the atmosphere. R. Whitaker

## ICE CREAM

**417. Costello's vegetable fat frozen dessert volume up to 1,500,000 gallons.** Anon. Ice Cream Trade J., **49**, 12. 1953.

The Costello Co., originally a cottage cheese firm in St. Louis, Mo., has sold 1,500,000 gal. of frozen dessert at a retail price of 35¢ a qt. during the past 12 mo. Half-gallon price is about 69¢. The product is sold in 3500 grocery stores in Missouri and Illinois.
W. H. Martin

**418. Coating chocolate bars.** R. A. Simonet, R. A. Johnston Co., Milwaukee, Wis. Ice Cream Trade J., **49**, 12. 1953.

A perfect operation should produce 38 three-ounce bars or 42 two-and-one-half ounce bars from a pound of coating. Numerous precautions and suggestions for obtaining maximum efficiency in coating operations are discussed.
W. H. Martin

**419. The number of fountains in supers has been growing.** Anon. Ice Cream Trade J., **50**, 1: 15. 1954.

The serving of light lunches and fountain items to customers and employees of supermarkets seems to be gaining in popularity. Lucky Stores, Inc., of San Leandro, California, have "W" shaped soda fountains in 5 of their 36 stores, which sell 29 per cent of their ice cream volume. The gross margin of profit at the fountain is 55%. W. H. Martin

**420. Ice cream in foreign lands.** Anon. Ice Cream Trade J., **50**, 1: 16. 1954.

One of the most fabulous ice cream empires in the world is operated by T. Wall & Sons, Ltd., of London, England. Three large factories, located at Craigmillar near Edinburgh, Godley near Manchester and Acton, near London, supply ice cream which is distributed throughout England, Wales, Scotland and Northern Ireland. Details of plant operation and distribution are described.
W. H. Martin

**421. Borden's newest ice cream plant.** Anon. Ice Cream Trade J., **50**, 1: 21. 1954.

A new Borden plant at Woburn, Mass. is designed to economize on handling materials and finished products, to save steps for plant workers, and to reduce labor costs by good planning and layout. Its potential capacity

is 2,000,000 gal. annually. Details of plant construction and equipment are presented.
W. H. Martin

**422. Six to twelve.** J. C. McWilliams, Jr., Bowman Dairy Co., Chicago, Ill. Ice Cream Trade J., **50**, 1: 28. 1954.

Factors to be considered in ice cream manufacturing in deciding on 6 or 12 specialty promotions throughout the year are presented. Six promotions give a better opportunity to simplify procurement of supplies, a better selling can be done, and it is easier to plan sales material for 6 specials than for 12. More time is provided to coordinate and organize promotional efforts. W. H. Martin

**423. What about soft served frozen products?** P. H. Tracy, Univ. of Ill., Urbana. Ice Cream Rev., **37**, 6: 102. 1954.

Results of a questionnaire submitted to mix manufacturers, operators of chain stores devoted to serving the soft served-product, independent soft served frozen store operators, equipment manufacturers and flavor and supply manufacturers are analyzed and discussed.
W. J. Caulfield

**424. Flavor injection unit for frozen dessert machines.** G. P. Grumbly. U. S. Patent 2,677,846. 5 claims. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 103. 1954.

A device for attaching to the outlet of a freezer for producing one or two flavors of soft ice cream or ice milk. Flavoring material is held in one or both of two supply tanks and introduced into the semifrozen mass through control valves. R. Whitaker

**425. Ice cream scoop.** A. G. Brown. U. S. Patent 2,669,194. 1 claim. Feb. 16, 1954. Official Gaz. U. S. Pat. Office, **679**, 3: 618. 1954.

A hand-operated scoop for dispensing ice cream in individual semi-spherical shaped portions. R. Whitaker

**426. Apparatus for converting a hard frozen confection into a plastic state.** F. W. Moffett, Jr. U. S. Patent 2,668,506. 5 claims. Feb. 9, 1954. Official Gaz. U. S. Pat. Office, **679**, 2: 369. 1954.

Hard ice cream in a cylindrical container is held in a form and a round perforated disc is forced down through the product to convert it to a plastic or soft condition. R. Whitaker

**427. Citrus-flavored sherbets.** O. E. Ross. Dairy World, **31**, 5: 10. 1952. (Chem. Abstr., **48**: 899i, 1954.) S. Patton

## MILK AND CREAM

**428. The effect of homogenized milk upon the viscosity of cornstarch puddings.** R. Jordan, E. S. Wegher, and H. A. Hollender, Purdue Agr. Expt. Sta., Lafayette, Ind. Food Research, **18**, 6: 649. 1953.

Comparisons of homogenized milk with nonhomogenized milk in the preparation of cornstarch puddings revealed that the former produces greater viscosity hot and more consistency cold, than the latter. The differences become greater as the amount of cornstarch used in the recipe, increases. Some evidence was obtained indicating that the cause of the increased thickness is attributable to the increased fat globule surface of the homogenized milk.
F. J. Doan

**429. Increasing homogenizer capacity in production of homogenized milk.** K. G. Savage and R. W. Brown. Can. Dairy Ice Cream J., **22**, 10: 30. 1953.

A satisfactory homogenized milk can be produced by separating milk and homogenizing the preheated cream portion (testing 9-12% fat), then recombining the processed cream with skimmilk and pasteurizing this reconstituted "homogenized" milk. Cream over 12% butterfat when homogenized results in excessive fat clumping and the emulsion of the finished product is unstable. This method produced av. plate counts below 10,000 per ml. and no sedimentations. This method can considerably increase the capacity of homogenizing equipment and should assist greatly in making the plant operations more efficient in cases where homogenizer capacity is limited. H. Pyenson

**430. The viscosity of cream.** K. G. Savage and R. W. Brown. Can. Dairy Ice Cream J., I, **32**, 8: 46. 1953, and II, **32**, 9: 42. 1953.

Results indicate that higher bacterial counts and higher coliform counts may be expected when cream is homogenized after pasteurization. A "critical" homogenization pressure may be reached at 3000 lb. per sq. in. After this, further increases in pressure may bring about decreases in viscosity. Little differences in viscosities of split vats of cream were noted when homogenization before and after pasteurization was compared. Viscosity of cream attributable to changes in processing sequence seem to be minimized at a temperature of 165° F. for 30 min. The use of a Fisher Electroviscometer (NO. 15-346-10) is considered a rapid, easy method for comparative evaluation of viscosity.
H. Pyenson

**431. Engineer's analyses of bulk milk handling.** C. M. Hall, Mich. State Coll., East Lansing. Milk Plant Monthly, **42**, 12: 13. 1953.

Most of the bulk milk installations in Michigan are in stanchion barns and the milk is carried in a milk pail and strained into the refrigerated bulk tank. Tank sizes range from 100-500 gal. with 150 and 200 gal. tanks predominating. The milk is picked up every other

day. The two types of refrigeration used on the farm bulk tanks are sweet water and direct expansion systems. The sweet water tanks of 200-gal. capacity cost approximately $300 less than the direct expansion type and about $100 less to install. Sweet water tanks of this size usually use a ¾ h.p. motor in comparison to a 2 h.p. for the direct expansion system. Assuming that there is no appreciable difference in the cost of repairs for the 2 types, based on a life of from 12-15 yr., they have approximately an equal cost of operation. The milk may be removed from the top of the tank through a vertical pipe or through a valve in the bottom of the tank. The valve costs about $50 and a tank so equipped requires a larger milk house. Each farm stop is a little longer than with the can system. However, if the milk is picked up every other day the time is about 2/3 as great and the cost to the farmer is usually about 10¢ less per 100 lb. C. J. Babcock

**432. Half-and-half homogenized milk. Effect of processing factors and added milk solids on flavor and viscosity.** G. M. Trout and B. R. Weinstein, Mich. State Coll., East Lansing. Dairy World, **31**, 6: 27. 1952. (Chem. Abstr., **48**: 898f, 1954.) S. Patton

**433. Chemical agents against tin taste in milk.** P. Swartling and E. G. Samuelsson, Statens mejeriförsök, Alnarp, Sweden. Svenska Mejeritidn., **45**, 215. 1953. (Chem. Abstr., **48**: 899a, 1954.) S. Patton

**434. Laboratory in the contest for the improvement of quality of milk and milk products.** M. Kravchenko, Aleksandrovsk Cheese Factory. Molochnaya Prom., **14**, 9: 9. 1953. (Chem. Abstr., **48**: 899d, 1954.) S. Patton

**435. A continuous process for preparation of milk for the manufacturing of dietetic sour dairy products.** M. Demurov, T. Romanovich, and L. Milyutina. Molochnaya Prom., **14**, 9: 21. 1953. (Chem. Abstr., **48**: 899e, 1954.) S. Patton

**436. Method and apparatus for milk sampling in dairy plants for determining the average fat content.** Paul Funke & Co. G. m. b. H. (Herbert Grimm, inventor). Ger. 820,817, Nov. 12, 1951 (Cl. 421, 18). (Chem. Abstr., **48**: 1604a, 1954.) S. Patton

**437. Method and apparatus for the thermal treatment of milk products.** Ecrémeuses Mélotte, Soc. anon. (Fernand J. J. J. Henrard, inventor). Ger. 820,841, Nov. 12, 1951 (Cl. 53e, 2). (Chem. Abstr., **48**: 1604a, 1954.) S. Patton

## PHYSIOLOGY AND ENDOCRINOLOGY

**438. Estimation of vitamin A depletion time in dairy calves.** R. Teichman, C. F. Helmboldt, J. E. Rousseau, Jr., E. L. Jungherr, H. D. Eaton, G. Beall, and L. A. Moore, Univ. of Conn., Storrs Agr. Expt. Sta., Storrs. Bull. 301. 1953.

Sixty-six calves consisting of 23 Holsteins and 15 Guernseys, age 105 d.; 14 Holsteins age 63 d.; and 14 Holsteins age 35 d. were placed on a vitamin A depletion ration until the blood plasma vitamin A level decreased to less than 4.0γ% for two consecutive wk. Investigation of the average rate of decrease of plasma vitamin A with consecutive 7 d. intervals fed the vitamin A depletion ration, indicated essentially a linear relationship. This rate was characteristic for age and breed, but not for depletion time, level of feeding of the depletion ration, sex, season or year. R. W. Hunt

**439. The effect of menadione on the rate of souring of milk.** G. G. Kelly and K. Kittmer, Fla. State Univ., Tallahassee. Milk Dealer, **43**, 4: 105. 1954.

When menadione, the precursor or substitute for Vitamin K, was added to milk at 37° C. it kept the milk sweet for significantly longer periods of time. When it was fed to cows at various low doses, it was found that 25 mg. per cow per d. kept milk sweet longer. Milk from cows which were not treated with the menadione generally soured in about 12 hr. when incubated at 37° C. Milk from cows which received 25 mg. of menadione per day remained sweet for a period varying from 18-24 hr. There was some variation within the same cows over a period of time. Data also are presented to show that feeding 13 mg. menadione per cow per d. retarded the souring of pasteurized milk 3-4 hr. at 37° C. The milk from cows treated with menadione had no detectable off-flavor. When it became sour, no hard, ropy curd formed nor did the putrid odor appear, which was usually present in sour control milk. C. J. Babcock

## SANITATION AND CLEANSING

**440. Economics of in-place cleaning.** J. R. Perry, National Dairy Products Coop., New York. Milk Plant Monthly, **42**, 12: 33. 1953.

In-place cleaning not only influences the cost but generally provides better cleaning results. Some of the economies obtained from in-place cleaning are: (1) Saving of time, (2) Reduction of wear and tear on processing equipment, (3) Reduction of wear and tear on the building, (4) Reduction in maintenance, (5) Reduction in the cost of brushes and cleaning compound, (6) Reduction in hazard and as a result in compensation, (7) Elimination of much costly "running down" of trouble with flavor, keeping quality, high bacterial counts

and undesirable bacteria, and (8) Reduction in the amout of specialized cleaning equipment.
C. J. Babcock

**441. Dairy plants from coast to coast are capitalizing on time and labor savings through the use of hydraulic jet cleaners.** ANON. Ice Cream Rev., **37**, 6: 49. 1954.

A jet cleaner requiring only inlet steam and cold water is reported to have the scrubbing effect equivalent to a man exerting 230 pounds of weight on a scrub brush. The jet cleaner has a specially designed mixing chamber and venturi injector assembly by which the heat from the steam is directly transferred to the water and detergent. There are no pumps, motors, heaters or other moving parts which require servicing or replacement.

Suggested uses include the cleaning of pasteurizers, surface coolers, pallet boards, floors, walls, milk bottle cases, and spray driers.
W. J. Caulfield

**442. Conventional lines cleaned-in-place.** C. C. FLORA, C. J. ARNOLD, and E. J. FINNEGAN. Milk Plant Monthly, **43**, 1: 21. 1954.

Data are presented which indicate that there is little difference between the conventional and clean-in-place methods of cleaning pipe lines insofar as the effect on sanitizing efficiency is concerned. There is very little difference between the 2 cleaning methods in the amounts and costs of cleaning and sanitizing materials required. The circulation or in-place method of cleaning is definitely superior to daily disassembly cleaning methods in labor cost. The circulation cleaning methods are definitely more favorable than daily disassembly methods from the standpoint of physical wear on the pipe line. Pyrex glass pipe can be used with satisfactory results insofar as bacterial quality is concerned.
C. J. Babcock

**443. Sequestration by sugar acids.** C. L. MEHLTRETTER, B. H. ALEXANDER, and C. E. RIST, Northern Regional Research Laboratory, Bur. of Agr. and Ind. Chem., U. S. D. A., Peoria, Ill. Ind. & Eng. Chem., **45**, 12: 2782. 1953.

The sequestering ability of several sugar acids including lactic, citric and gluconic toward calcium, ferric and cupric ions in acid to strongly alkaline solutions was studied. The sugar acids are non-toxic and may be used as sequestrants in food processing. They should be especially useful in washing preparations for glassware in hard water areas.
B. H. Webb

**444. Comparative cleaning of diphase and emulsion systems measured by radioactive tracers.** L. OSIPOW, G. SEGURA, JR., C. T. SNELL, and F. D. SNELL, Foster D. Snell, Inc., New York, N. Y. Ind. & Eng. Chem., **45**, 12: 2779. 1953.

Emulsion and diphase cleaners were used to clean steel surfaces having three tagged versions of the same soil. The diphase cleaner removed more soil in 1 min. than did the emulsion cleaner in 5 min. The use of radioactive tracers makes it possible to measure the amount of soil retained on test sheets and the selective removal of individual tagged components of the soil mixture can then be quantitatively evaluated. It was concluded that diphase systems clean greasy soil from metal much more rapidly than do emulsion systems.
B. H. Webb

**445. Recent developments in design of small milk-waste disposal plants.** J. P. HORTON and H. A. TREBLER, Natl. Dairy Research Labs., Inc., Oakdale, N. Y. Sewage and Ind. Wastes, **25**: 941. 1953. (Chem. Abstr., **48**: 1613d, 1954.)
S. Patton

**446. Cattle and hog insecticide applicator.** C. H. MURRAY and D. E. BREITHAUPT. U. S. Patent 2,667,859. 1 claim. Feb. 2, 1954. Official Gaz. U. S. Pat. Office, **679**, 1: 107. 1954.

A tubular applicator is stretched taut between the top of a post several feet high and a stake close to the ground. Liquid insecticide is squeezed out of the applicator onto the animals when they rub themselves against the rough surface of the applicator.
R. Whitaker

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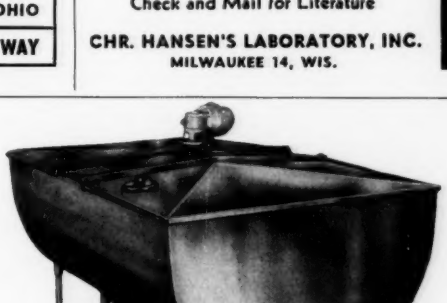

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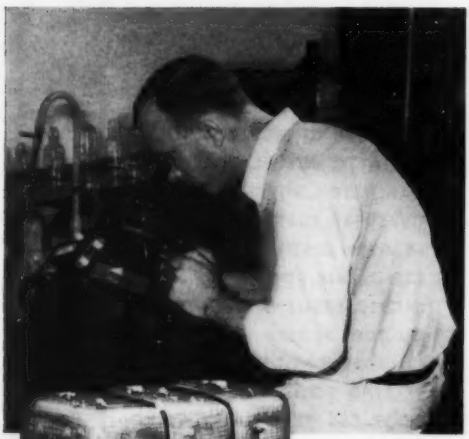

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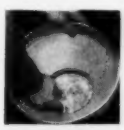

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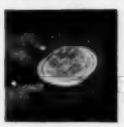

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